Materials in Design Engineering

FORMERLY
MATERIALS
& METHODS

SELECTION & USE OF METALS, NONMETALLICS, FORMS, FINISHES

DIE CASTINGS

MANUAL NO. 163

ALSO: METAL SHOW PREVIEW

URETHANE ELASTOMERS

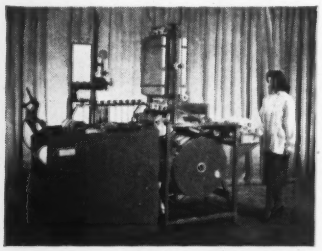
IMPREGNANTS FOR CASTINGS

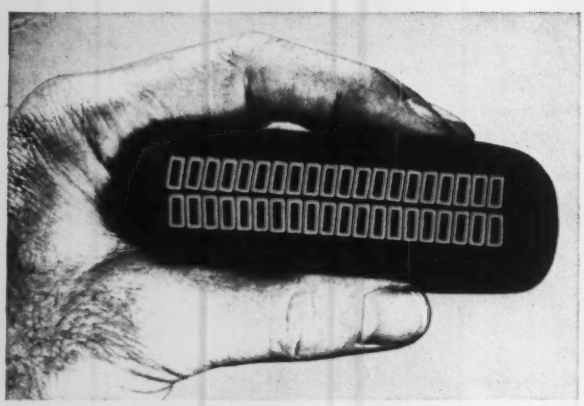
COMPLETE CONTENTS—PAGE 1

OCTOBER, 1959

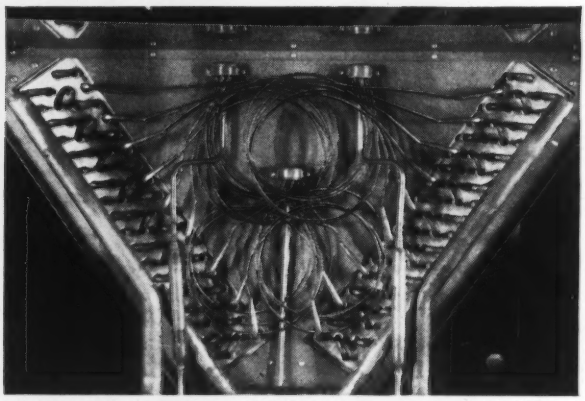
BETTER WAYS of doing things with seamless copper tube are unlimited—from capillary sizes to 26-inch diameter—round tubes or special shapes.

A better product faster. In the Kodak Roll Paper Dryer-Glazer shown below, photographic print paper travels around a heated, mirror-smooth, chromium-plated copper drum. This drum could be formed from sheet metal, welded and ground. But Eastman Kodak Company takes a production short cut and buys the drums ready made—Anaconda seamless copper tube 26" inside diameter, in wall thicknesses of ⅛", cut to 20" lengths. Having the thermal conductivity and corrosion resistance needed, the tube is also easy to polish to a high mirrorlike finish (photo, left), provides an excellent base for fine chromium plating. No seams mar the surface. Production time and steps are cut.





Rectangular copper tube carries current and coolant. By liquid cooling conductors in generator stator bars, General Electric has opened the way to doubling generator ratings without appreciably increasing frame size. Tubes, approximately 0.300" x 0.130" O.D., shown in cross section above, are shipped in long coils. Special-shape tubes are available in a wide variety of sizes, cross sections, and alloys.



High-precision tubes meter fluids. York Corp., subsidiary of Borg-Warner, has found restrictor-tube metering of refrigerant in packaged air-conditioning units up to 25-ton capacity has greatly reduced field service, made possible the 5-year protection plan on all units. Anaconda Copper Restrictor Tubes have consistently met York's strict requirements. These tubes are available in copper or aluminum in nominal I. D.'s from .025" to .090".

WHETHER you need long lengths of copper capillary tubing for air, hydraulic, or lubricating lines or for instrument tubing—or large-diameter tube in copper or a copper alloy, call your American Brass Company representative. He can help you select the product you need from the broadest range of seamless tubes available to industry. Or write: The American Brass Company, Waterbury 20, Conn. In Canada: Anaconda American Brass Ltd., New Toronto, Ontario.

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Materials
in Design Engineering, *formerly Materials & Methods*

Selection & use of metals, nonmetallics, forms, finishes

OCTOBER 1959
VOL. 50, NO. 4

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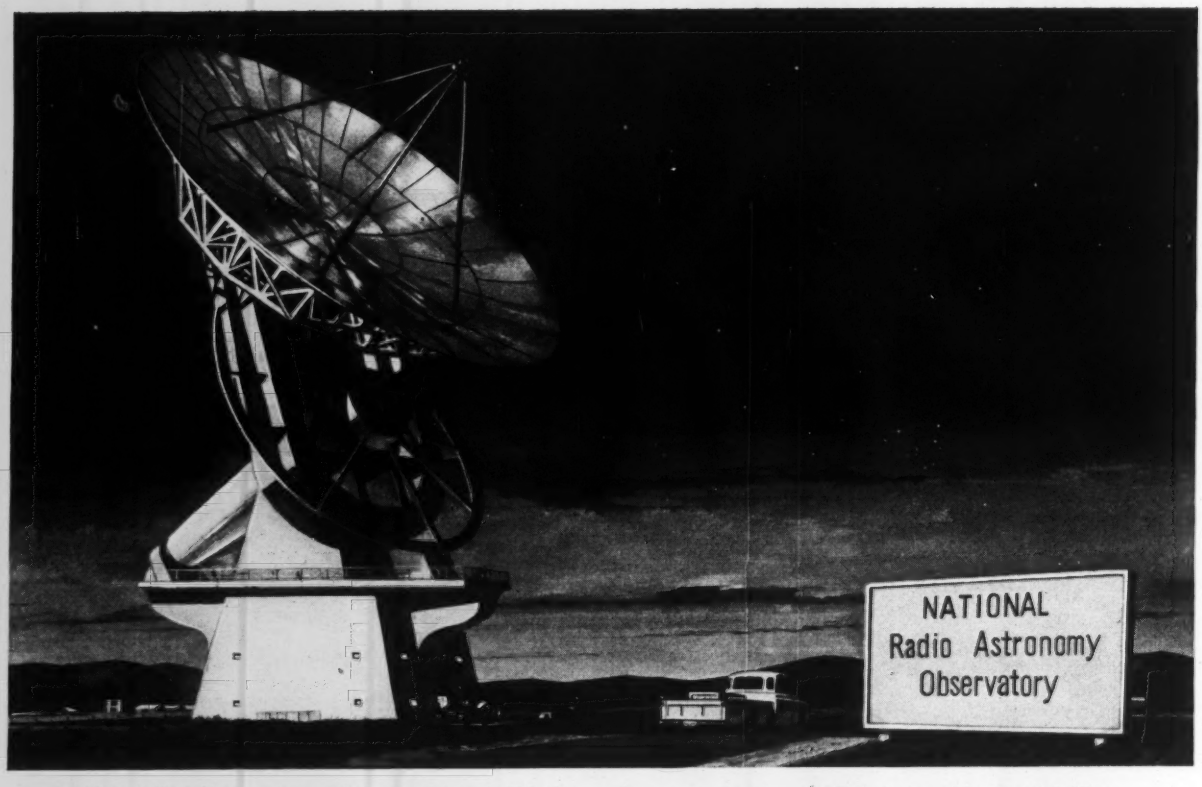
COVER BY HARRY & MARION ZELENKO



This radio telescope is now being constructed by the E. W. Bliss Company of Canton, Ohio, at the National Radio Astronomy Observatory at Green Bank, West Virginia. Nickel-alloyed ductile iron is used for support and control parts to achieve watch-like accuracy in guiding the 5-million-pound instrument. The telescope will be operated by Associated Universities, Inc. for the National Science Foundation.

Eavesdropper at the keyhole of an invisible universe

Objects far out in space that cannot be seen with the most powerful optical telescope can now be studied by astronomers.

They do it with an amazing instrument called the radio telescope which can detect radio waves coming from objects that may be as much as *5 billion light years away!*

It may sound fantastic, but that's exactly what this 140-foot telescope at National Radio Astronomy Observatory will do. And although its moveable parts weigh close to 5 million pounds, watch-like accuracy is being built into every foot, every pound.

Take the cannon-like polar axis shaft, which can be seen pointing skyward in the picture. Sixty-seven feet long and 12 feet across, this shaft will be driven by a gear 85 feet in diameter and a foot thick, with teeth machined to be accurate to within thousandths of an inch.

They'll stay accurate, too. For these parts, as well as the 8 bearing pads supporting the massive assembly, are made of nickel-alloyed ductile iron, a remarkable metal developed by Inco research.

It is Nickel which gives this alloy the extra strength and wear resistance without loss of toughness needed for these parts. Unlike ordinary cast iron, nickel-alloyed ductile iron is not brittle. It can be bent or twisted. It is several times stronger than cast iron, yet easy to cast and machine.

Don't forget nickel-alloyed ductile iron even if you're not thinking of building a radio telescope anytime soon. This versatile metal has hundreds of applications in every industry.

So do Nickel and other Nickel Alloys. Be sure to consider them whenever you need a metal with superior ability to withstand destructive service conditions. And don't hesitate to call on Inco for any technical data or other help you may need. Our booklet, *Engineering Properties and Applications of Ductile Iron,* is typical of the informative material that can be yours for the asking. Write for a copy.

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What's new IN MATERIALS

...AT A GLANCE

Two high strength titanium alloys are said to have properties that are radically different than those of conventional titanium alloys. One alloy (90 Ti–10% Cr beta) can be hardened to a tensile strength of 220,000 psi in less than 1 hr at 800 F; a conventional beta titanium alloy requires more than 1000 hr at 800 F to reach the same strength. The other new titanium alloy (78 Ti–20 Al–2% V alpha) has low density—4.1 lb per cu in.—and good oxidation resistance at temperatures up to 2000 F. (More details next month.)

Source: Alloys developed by Chicago Development Corp., 5810 47th Ave., Riverdale, Md. in cooperation with Manganese Chemicals Corp., Rand Tower, Minneapolis 2, Minn. The alloys are available in limited quantities from Manganese Chemicals Corp.

A heat resistant glass-phenolic laminate does not blister or delaminate after rapid heating from room temperature to 1000 F. The new material is recommended for missile and aircraft structural parts operating in the temperature range 700-800 F. The developer is supplying the material as custom molded parts. (More details next month.)

Source: Riverdale Plastics Corp., 220 Miller Rd., Hicksville, N. Y.

An increase in the elevated temperature limit of 12% chromium steels from 1050 F to 1200 F has been made possible by the development of a new, modified 12% chromium steel in England. The steel has a 151,000 psi tensile strength at room temperature and 60,000 at 1200 F. The alloy is now available in this country in the form of billet, bar, wire, strip and special shapes. (More details next month.)

Source: Carpenter Steel Co., 101 W. Bern St., Reading, Pa.

A new tester tells how clean the surface of a material is before coating, bonding or plating operations. The device assigns numerical values for surface cleanliness where nonbonded soils are involved. These cleanliness values can be used to compare various cleaning techniques and equipment, to evaluate effectiveness of cleaning agents, and to determine the working life of detergents and solvents.

Source: Branson Ultrasonic Corp., 40 Brown House Rd., Stamford, Conn.

A new high strength silicone rubber joins two other high strength silicones introduced in 1957 (see *Materials & Methods*, May '57, p 187). The newer material has a tensile strength slightly over 2000 psi, a tear strength of 325 psi and an elongation of 600 F. It is said to remain flexible at −105 F, and is unaffected by weather, sunlight or ozone. (More details in a forthcoming issue.)

Source: Connecticut Hard Rubber Co., 407 East St., New Haven 9, Conn.

Zinc alloys with excellent resistance to creep and grain growth may compete with more expensive nonferrous alloys for use in fabricated structural and ornamental parts. The alloys, which contain copper and titanium, are also said to have a substantially lower coefficient of linear expansion than any other zinc alloy produced in strip and sheet form. Tests show that a typical alloy changes in length at the rate of about 1% in 13.5 years under a constant load of 10,000 psi. The developer

has licensed other rolling mills to produce the alloys. (More details in a forthcoming issue.)
Source: New Jersey Zinc Co., Market Development Div., 160 Front St., New York 38.

High purity, single crystal silicon carbide grown by a new technique shows promise of operating in semiconductor devices at temperatures up to 1800 F. Presently used germanium or silicon semiconductor devices can be used only to 450 F. The new crystals are made by allowing the carbon of a crucible to diffuse into molten silicon until saturation is achieved, then carefully cooling a localized portion of the solution. The silicon carbide crystals are grown from the supersaturated solution.
Source: Stanford Research Institute, Menlo Park, Calif.

The 300 series stainless steels can now be polished and descaled easily with a new chemical immersion technique that uses no electricity. The developer of the technique says that close tolerances can be maintained on parts being processed, since the solutions used have only a slight corrosive effect on type 300 stainless steel. Although strongly acidic, the solutions contain no harmful fluorides.
Source: Diversey Corp., Metal Industries Dept., 1820 Roscoe St., Chicago 13.

A polycrystalline ceramic that readily transmits light has been made from powdered aluminum oxide. The material is translucent because microscopically small pores, or "bubbles," which are normally found in ceramic materials have been entirely removed by firing at high temperatures. The developer says the new material is also able to withstand higher temperatures than most ceramics. It can be pressed into any shape desired. (More details next month.)
Source: General Electric Co., Research Laboratory, Schenectady, N. Y.

A substantial increase in the fatigue life of cap screws is promised with the development of a new thread form that has round roots with smooth edges as compared to conventional cap screws which have flat roots with sharp edges. The thread form is also said to increase the usable static tensile strength of cap screws by as much as 2½%. The screws are expected to find use in tension applications where there is appreciable vibration or dynamic loading, such as machine tools, mechanical equipment and appliances.
Source: A. W. Scott, Standard Pressed Steel Co., Jenkintown, Pa.

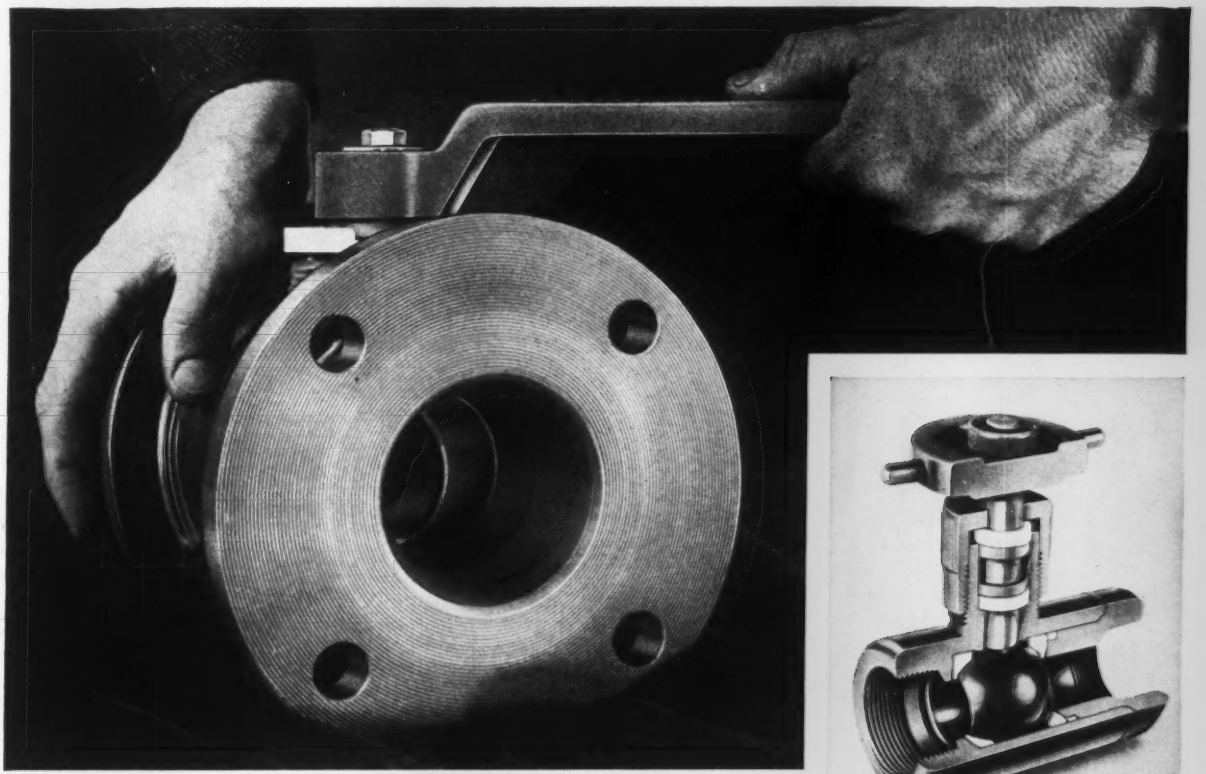
High purity refractory metals for nuclear and missile parts will soon be turned out in a new electron beam furnace that is capable of melting and producing tungsten, tantalum, columbium, beryllium, molybdenum, vanadium and their alloys in ingots 5 in. in dia by 42 in. in length. Hafnium, zirconium, rare earth metals and special stainless steels have also been successfully melted and cast in this furnace.
Source: Wah Chang Corp., Albany, Ore. and Stauffer Chemical Corp., 380 Madison Ave., New York 17.

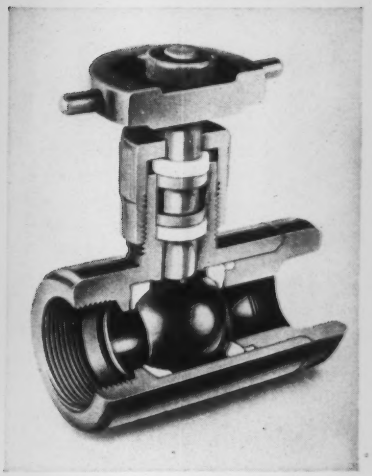
Aluminum alloy 5456 is available as sheet for the first time. The high strength alloy, formerly available only in plate, is now rolled in thicknesses ranging from 0.051 to 2 in. The aluminum alloy sheet has a guaranteed minimum tensile strength of 51,000 psi in the H24 temper.
Source: Aluminum Co. of America, 1501 Alcoa Bldg., Pittsburgh 19.

Turn to page 133 for more "What's New in Materials"

News about

B.F.Goodrich Chemical *raw materials*





Valves by Jamesbury Corp., Worcester, Mass. Geon rigid vinyl parts molded by Mannesman-Easton Plastic Products, Inc., Easton, Pa. Valves in sizes from 1/2" to 4", shown in large photograph, are rated at 150 psi to 100 F. and at 50 psi to 130 F. They can be remote operated. B.F.Goodrich Chemical Company supplies the Geon rigid vinyl material only.

New ball valve of Geon helps piping systems fight corrosion

Thousands of test cycles with this new valve made from Geon rigid vinyl have proved the effectiveness of its seal, either at full pressure or vacuum. Since it is made entirely of Geon except for seats and seals, it offers pipe users another weapon for the battle against corrosion. Geon offers superior resistance to oils, acids, alkalies and most chemicals.

In addition, rigid Geon weighs less than metal. Shipping weights are lower, installation is easier. These valves can be obtained with threaded ends, weld ends, or flanges. They are self-compensating for changes in pressure or temperature. There is no problem of galling or seizure. No lubrication is needed.

Geon offers remarkably varied opportunities for products that open new markets or improve present applications. In rigid form it is being used for pipe, window frames and ductwork . . . in other forms for weatherstrip, wall coverings, foam products, or coatings for metal, paper or textiles. One member of the Geon family can surely help you make a better product. Write for information to Dept. AR-4, B.F.Goodrich Chemical Company, 3135 Euclid Avenue, Cleveland 15, Ohio. Cable address: Goodchemco. In Canada: Kitchener, Ontario.

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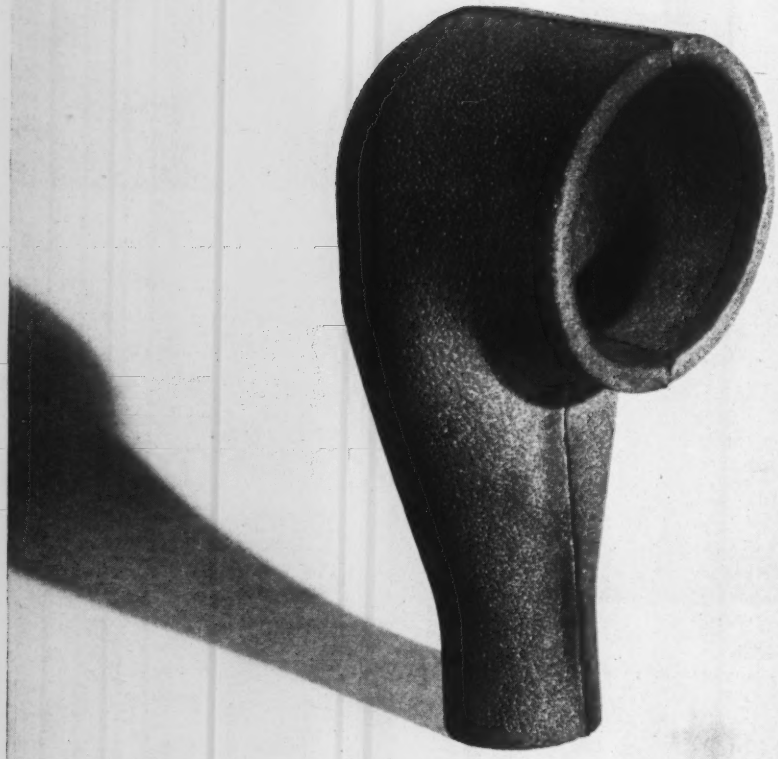

Know what to make of this?

B.F.Goodrich does . . . because it's their cellular material in one of the thousands of forms and shapes it can take. In this case, it's a component for a refrigerated cabinet.

In sponge rubber or cellular plastic, B.F.Goodrich industrial cellular materials are excellent for insulation, flotation, shock absorption, sealing, cushioning and vibration damping – under even the most trying conditions imaginable.

If you have a product that's in trouble or could be – ask us. B.F.Goodrich specialists are ready to help. Write The B.F.Goodrich Company, 521 Derby Place, Shelton, Connecticut. Or, if your problem needs immediate discussion, phone Cellular Engineering, REgent 5-4661.

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MATERIALS AT WORK

...AT A GLANCE

Ceramic brazing jigs for rocket motors

Brazing jigs used in the production of rocket motors are now being made of ceramics. Here's why: the ceramic material's low thermal conductivity 1) permits motor tubes to be thoroughly brazed together; 2) allows jigs to be precision formed; and 3) prevents the brazing material from becoming brittle as a result of rapid cooling. In addition, the ceramic resists wetting by the brazing material. The jig is equally suitable for furnace or torch brazing and is said to retain its shape after repeated use.

Source: Gladding, McBean Co.

World's tallest structure to be galvanized

Hot dip galvanizing has been specified for the world's tallest man-made structure—a TV tower soon to be erected in Deering Junction near Portland, Me. The tower, consisting of 300,000 lb of structural steel, will be 1619 ft high—147 ft higher than New York's Empire State Building.

Source: Southern Galvanizing Co.

Phenolic laminate insulates miniaturized synchros

Use of a cotton-base phenolic laminate has solved a difficult insulating problem in the design of miniaturized synchros and low-inertia motors used in jet aircraft. The problem: to replace the previously used paper wedges which tended to break or swell when size requirements were reduced to 0.062-0.140 in. dia. The new wedges, produced with a ±0.005-in. tolerance, have a Rockwell hardness of M105, a compressive strength of 37,000 psi, and a maximum water absorption of 4%.

Source: Taylor Fibre Co.; wedges used by Eclipse Pioneer Div., Bendix Aviation Corp.

Miniature tantalum capacitors

A tiny piece of tantalum sponge—0.1 in. in dia and 0.3 in. long—is the heart of a new capacitor which is said to be "one of the major keys to electronic miniaturization on a scale not before achieved." The hard, sponge-like pellet has a "working area" equivalent to 48 sq in. Its capacitance is said to be equal to that of a conventional unit 8 in. long and ½ in. in dia. To make the tiny sponge, a special sintering process fuses compressed powder under temperatures of more than 3600 F in a vacuum furnace.

Source: General Instrument Corp.

Prepainted aluminum for insulation jacketing

The first industrial use of prepainted aluminum for insulation jacketing has eliminated the time consuming and costly job of painting insulated pipes and vessels in a gas processing plant. The enameled aluminum, 0.016 and 0.024 in. thick, not only reduced costs but provided an operating advantage as well: in the event of damage to the enamel, the aluminum will resist most types of corrosion.

Source: Reynolds Metals Co.; used by Superior Oil Co.; installed by Fuller-Austin Insulator Co.

Acetal fasteners may compete with metal

Excellent strength, resilience, corrosion resistance, ease of fabrication and light weight are the reasons given for the suggested use of acetal resin (Du Pont's

(continued on p 9)

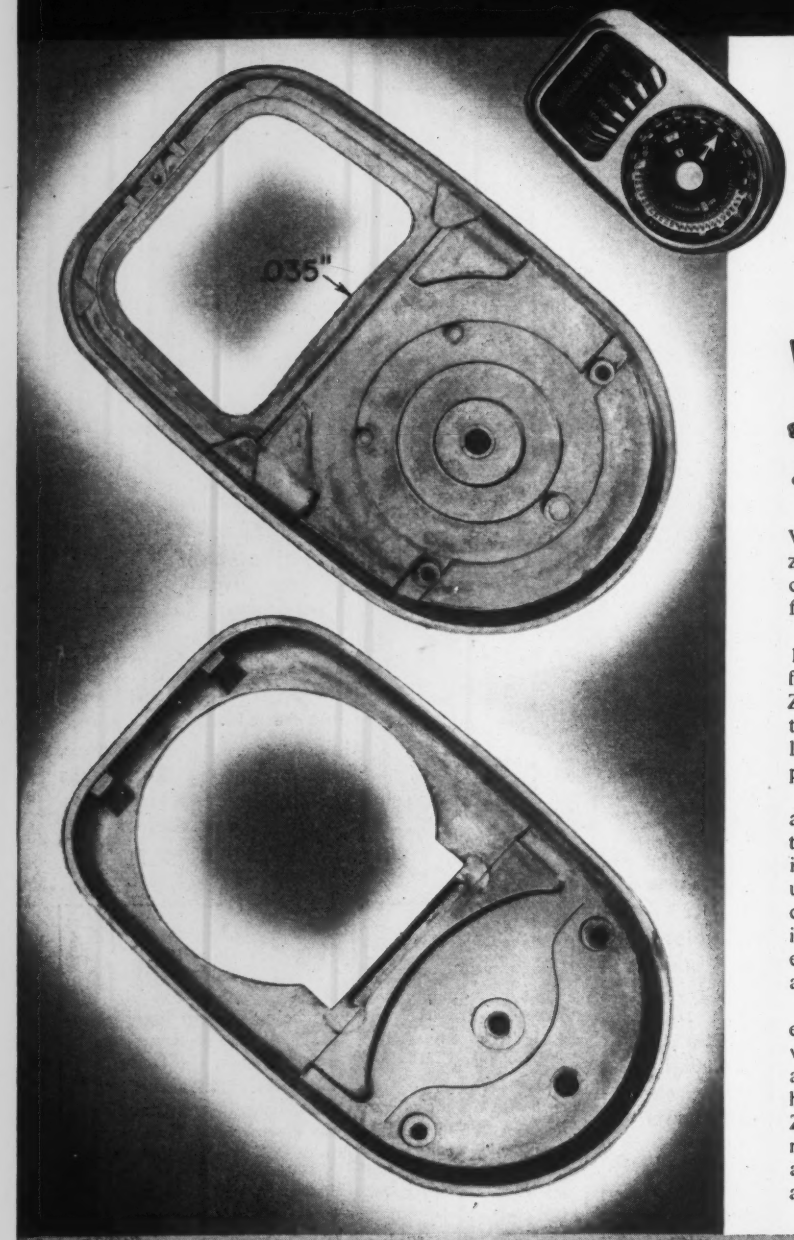
Briefs

Broken bones are now being glued together with urethane foam. Little plugs of bone are removed from the broken bone ends, the foam is poured, the plugs are replaced (so that the two ends of bone dovetail), and several hours later the limb can be moved. Normal bone eventually grows through the urethane glue, which is absorbed.

Stainless steel that floats in water is one of the latest developments to come out of the missile research program. The development resulted from the discovery that porous stainless, used for another purpose, is buoyant in water.

Grass seedings covered with polyethylene film for the first few days are almost sure to sprout even in semi-arid areas. The film keeps moisture in the upper half inch of soil.

IT'S LIGHTER THAN YOU THINK!



EXCEPTIONALLY ACCURATE... STRONG... ECONOMICAL... WHEN DIE CAST with ZAMAK

WESTON has been using these wafer-thin zinc die castings for the front and back covers of this world-famous exposure meter for 14 years.

Converting from an all-plastic case in 1945, Weston selected zinc die casting alloys for this popular precision instrument because ZAMAK offered the most in all-'round advantages. High strength combined with the lightness of a thin-wall zinc die casting were primary considerations.

Extreme accuracy of dimensions, as-cast, and the convenience of casting contours on the inside of the case for mounting to the instrument were additionally important values. Ease of assembly of the tamper-proof construction and a lasting, satin-chrome finish were extra dividends – all of these and economy, too, when die cast with ZAMAK alloys.

As in many other applications, such extremely thin wall sections – possible only with zinc die castings – minimize weight and are stronger **in proportion to thickness** than heavier sections. Such parts designed for ZAMAK alloy die casting will more than meet competition of either stampings or aluminum castings – provide many more advantages and all at lower cost.

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THE NEW JERSEY ZINC COMPANY

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newest plastic; see M/DE, Jan '58, p 155) for industrial pipe plugs and other threaded fasteners. The plugs are said to provide seals against pressures as high as 10,000 psi; even after repeated cycling from room temperature to 250 F, pressures of 500 psi are held. Soon to be commercially available, the plugs are expected to cost about the same as plated or nonplated brass, high-grade carbon steel and stainless steel.

Source: E. I. du Pont de Nemours & Co.

Ductile iron supports cables on bridge

About 100,000 lb of ductile iron castings are being used to support electric cables on New York's Queensborough bridge. The cables are housed in 8-in. pipes welded in continuous lengths and covered with glass-reinforced epoxy. The supports, each weighing about 250 lb, have six rollers which support as many cable pipes. The rollers are covered with a polyester laminate to protect the pipe covers. Ductile iron castings were specified in preference to welded steel because they cost less, yet provide the necessary corrosion resistance and strength.

Source: International Nickel Co.; castings made by Crompton & Knowles Corp.; used by Consolidated Edison Co.

Semiconductors to revolutionize electronic devices

Revolutionary changes in electronic equipment may result from the development of two new semiconductor devices. One is an experimental electron tube that gets its supply of electrons from a tiny crystal of silicon carbide. The crystal replaces the hot, power consuming cathode usually found in conventional electron tubes. The other semiconducting device is an improved tunnel diode. Electrical charges move through the device with the speed of light, in contrast to the relatively slow motion of electrical charge carriers in transistors.

Source: Westinghouse Electric Corp. (electron tube); General Electric Co. (tunnel diode).

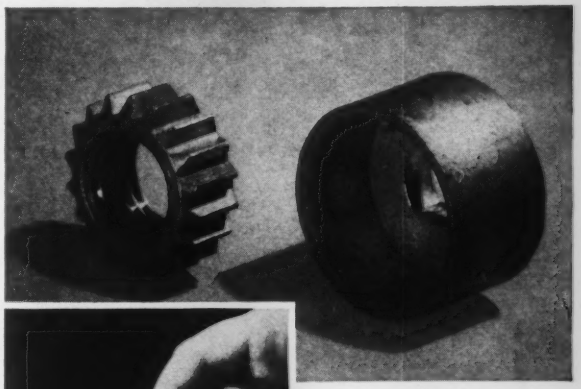
Urethane foam insures accurate steel analysis

A 1-in. thick blanket of urethane foam has solved the problem of temperature variations in a critical vacuum spectrometer used in steel analysis. The spectrometer, which can analyze up to 23 elements simultaneously, previously had to be adjusted several times a day to compensate for temperature variations which could destroy accuracy of the analysis. The urethane insulation, which is mounted with clips to provide ready access to controls, eliminates frequent adjustment and assures accuracy.

Source: E. I. du Pont de Nemours & Co.; urethane supplied by General Tire & Rubber Co.; spectrometer manufactured by Allied Research Laboratories.

(more Materials at Work on next page)

ADVANTAGES SUCH AS THESE with **METAL POWDERS**



REDUCE COSTS and RETAIN HIGH QUALITY

These precision parts for the HALSEY W. TAYLOR COMPANY water fountain valve were formerly made on a screw machine. The handle-adjusting nut (left) was cut from pinion stock and the lock sleeve (right) required broaching for nut engagement—all expensive operations leading to high parts cost.

Switching to BRASS POWDER METALLURGY, the Taylor Company now obtains both parts—ready for assembly—from a custom powder fabricator.* Costs are greatly reduced and every piece is of uniformly high quality.

Brass powder metallurgy can produce accurate, low-cost components for your products as well. See a metal powder fabricator for detailed information.

** Merriman Brothers, Inc., Boston, Mass.*

THIS BOOKLET

will assist you in evaluating this modern production method in terms of your particular needs.

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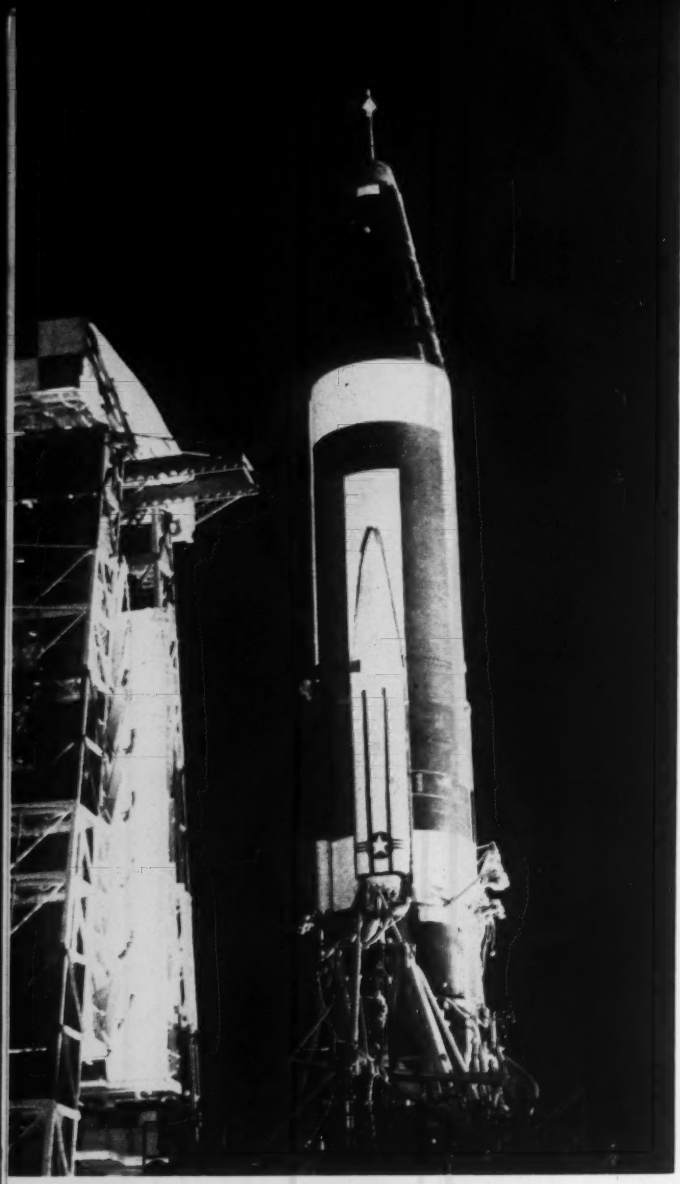
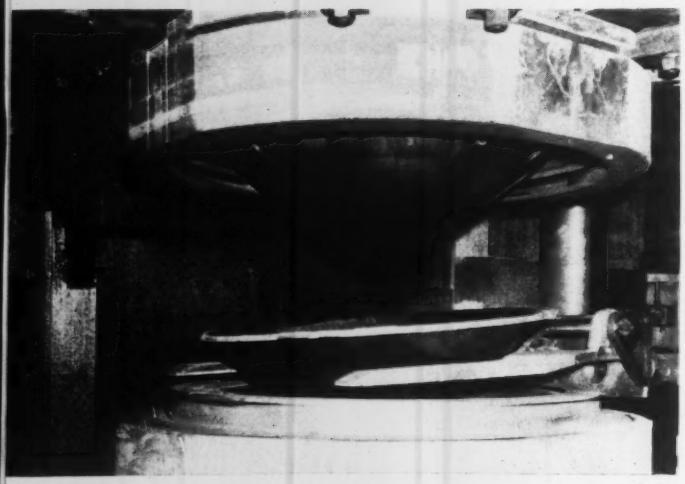




MATERIALS AT WORK

Edited by
Walter Lubars

The Atlas Missile:

a thin stainless skin . . .

Some interesting details on the construction of the main body section of the Atlas missile have recently been released by the Air Force.

Here are some of the facts: 1) the body section—a hollow tank 60 ft long and 10 ft in dia—is made of type 301 stainless steel; 2) the heaviest skin gage is less than 0.040 in.; 3) the thinnest wall section has minimum tensile strength of 200,000 psi; 4) there are no internal supports or framework, the tank's shape being maintained by internal gas pressure.

According to Convair, a division of General Dynamics Corp., the special tank design provides the maximum strength-weight ratio. The rolled 301 stainless is supplied by Washington Steel Corp. This alloy was selected because of its toughness; ease of handling; excellent strength-weight ratio; resistance to heat, cold and corrosion; and ease of forming and welding.

Here's how the tanks are built: flexible bands of the thin-gage steel, about a yard wide and 30 ft long, are butt welded and reinforced with an underlying strip of stainless. Several of these bands are then joined by lap welding to form a tank. During construction, the tank is supported by solid rings; when the tank is completed, gas is pumped in and the supporting rings removed.

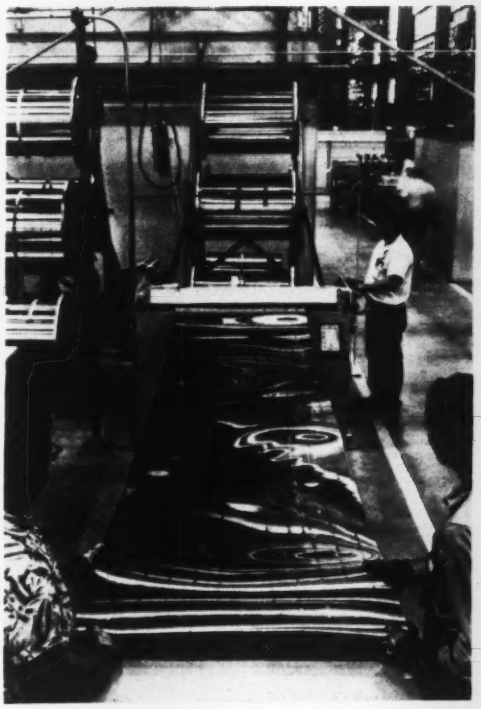
. . . and a heavy copper nose cone

Shown at the left is what is said to be the largest copper closed-die forging ever made.

Used as the nose cone in the Atlas missile, the forging weighs nearly one ton. It is 5 ft in dia, 2 ft deep and 1¼ in. thick.

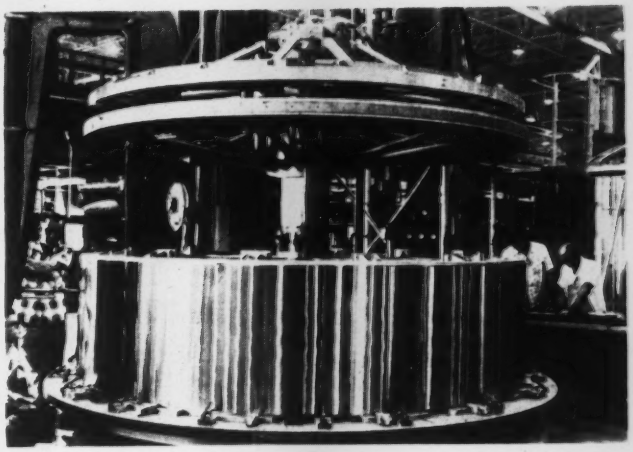
According to Wyman Gordon Co., the nose cone is forged in one pass on a 50,000-ton press. The copper forging billet, which has a minimum copper content of 99.9% and a maximum oxygen content of 0.05%, is 28 in. in dia and weighs about 9000 lb.

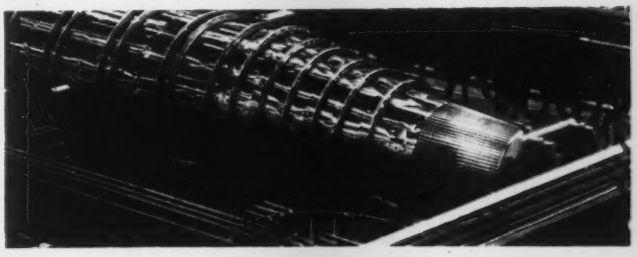
After being sawed to desired length and freed of casting defects, the billet is heated and upset to a pancake shape 30 in. in dia and 9 in. thick. The pancake shape is partially formed in an 18,000-ton press, trimmed of flash and inspected. The part is then reheated and formed to final shape.



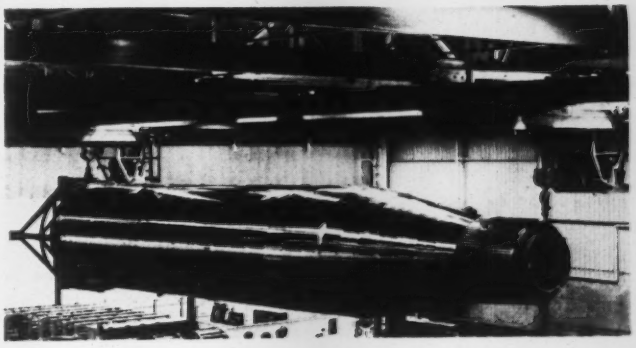
Thin gage 301 stainless steel . . .

. . . is stretched on special machine (top right) and butt welded to form flexible bands which are . . .





. . . lap welded to form general shape of body section. When unit is completed . . .



. . . supporting rings are removed and pressurized gas maintains missile's shape.

World's largest tire

The overgrown tire shown at left weighs two tons; is 10 ft high and 4 ft wide; uses a one-ton rim; and sells for $14,000.

According to Goodyear Tire & Rubber Co., the giant tire will be used on earthmoving equipment presently being designed. Vehicles equipped with the tires will be capable of carrying more than 30 tons at 35 mph. The tires require an air pressure of only 35 psi.

Better 'Thermos' bottle at reduced cost by . . .

Adhesive bonding polyethylene to glass

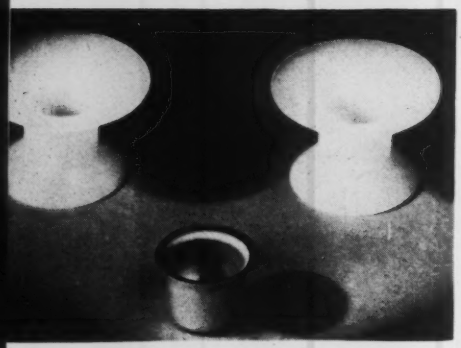
Circular pattern of adhesive *formed by special machine provides high strength bond.*

In order to provide greater protection for the hermetically sealed tip of the double-walled glass vacuum container used in "Thermos" vacuum bottles, a switch from aluminum to polyethylene was specified for the shock absorbing tip protector (see photo).

According to American Thermos Products Co., the switch provides these advantages: greater bonding area, easier assembly, improved resiliency and reduced manufacturing costs. However, it created this major problem: no commercially available adhesive, including the epoxy formulation previously used, would bond the traction-free polyethylene part to the smooth glass surface.

When it became apparent that existing adhesives

(continued on p 197)



Polyethylene tip protector *performs better, costs less than previously used aluminum cap.*

MORE MATERIALS AT WORK

Jet engine parts now formed by explosives 197
Dacron-Mylar sphere to invade outer space..... 198
Largest titanium head..... 200
Phenolic laminate reduces shuttle cost 202
Cast stainless blade simplifies wire peeling 204
Polyethylene chutes best for concrete 206
Magnesium oxide key to cold cathode 208
Largest stainless plates 208
Stainless baskets best for pickling 210
Urethane-filled bronze cuts destroyer weight 212

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More SAMPE groups . . .

To the Editor:

We in St. Louis were highly pleased to read your "Last Word" editorial in the July issue regarding SAMPE. This is a very good write-up. However, I would like to add mention of our new group here in St. Louis. We organized in February of this year and are looking forward to being active in the national organization that we hope will be formed this fall.

Also, there are three groups on the West Coast, not two, as stated in the editorial. This adds to a total of seven groups instead of five.

STEWART J. STOCKETT
Secretary
St. Louis SAMPE

. . . and thanks

To the Editor:

We want to thank you for the splendid editorial, "A Materials Society for You," which appeared in your July issue. It is certainly all that we could ask for in the way of an endorsement from such an outstanding publication. We will keep you informed on the progress that is being made by the Southwest Section.

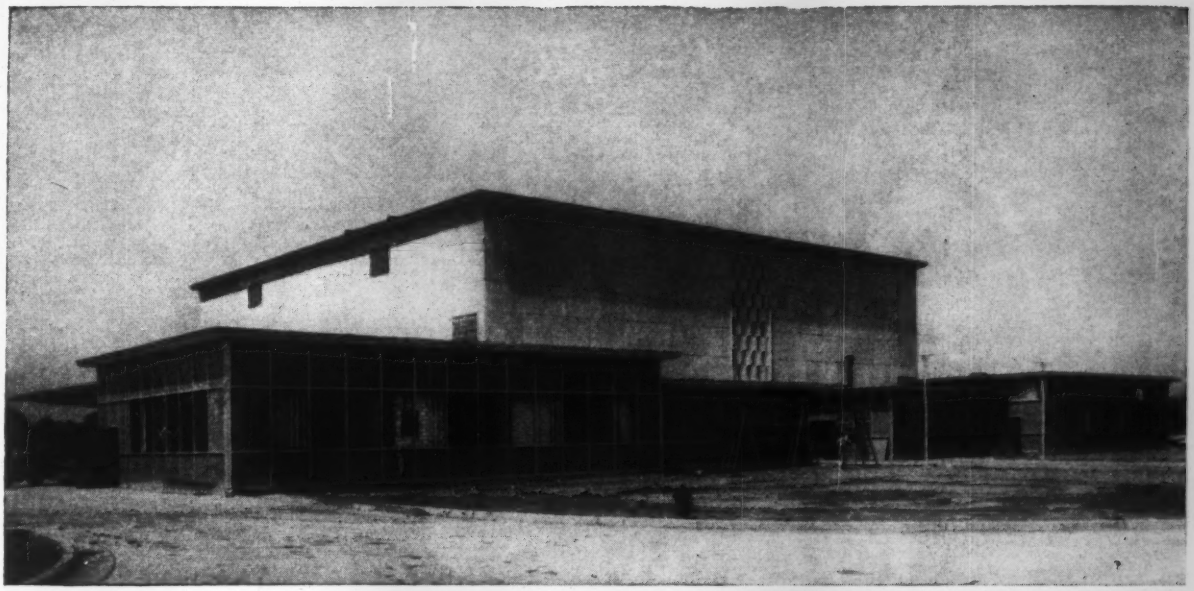
RUSSELL REMBERT
President
Southwest SAMPE

SAMPE objectives

To the Editor:

In the July issue your editorial discussed the Society of Aircraft Materials and Process Engineers. Many of your readers might be interested in learning more about this relatively new organization. As the name implies, the primary interest of the group centers on materials and processes, areas in which there is great interest among aircraft and missile industries. It is a moot question whether the word "Aircraft" should be dropped from the title. It is true that, in the long run, materials and processes are important to a much wider group of engineers.

A number of the national engineering associations frequently present technical papers dealing with materials and processes, but neither to the extent nor in a manner deemed necessary by many engineers. The frequent lack of an opportunity to discuss such details led to the formation of this new group. Clearly materials and processes cut across the lines of many engineering disciplines, embracing as they do the fabrication and production of units or components from nonmetallics as well as metals and composites thereof. Thus the chemist, the ceramics engineer, the metallurgist, the mechanical engineer, the physicist and the plastics engineer may



Architect: Voorhees, Walker, Smith, Smith & Haines
Contractor: Frank Briscoe

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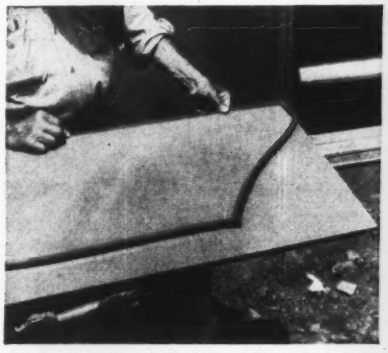

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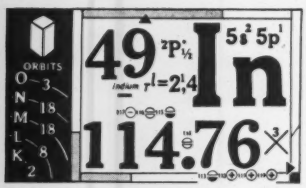

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find common areas of interest in the new society.

The initial organization originated among aircraft materials and process engineers in the Los Angeles area. Similar groups were then formed in other regional areas. Last year the Eastern Div. began operation and held a successful fall meeting in Washington, D. C. This, and the subsequent meeting in New York City, has encouraged the formation of local chapters in the Boston, New Haven–Bridgeport, Long Island, Philadelphia, and Washington–Baltimore areas.

About 1000 engineers in various industries have signified interest in a national organization. A meeting to consider consolidation of the groups into a national society will be held in Los Angeles in conjunction with a three-day symposium on sealants and sealing of aircraft, missiles and electrical components (Oct 28-30). Plans are also being made for a Midwest SAMPE-sponsored symposium on lightweight, heat resistant materials for re-entry and aerodynamic heating, to be held in Dayton, Ohio in March, 1960.

GEORGE E. HOLBACK
President
SAMPE Eastern Div.
Arlington, Va.

For two divergent views on SAMPE—con and pro—see Mr. LaQue's letter on p 249 of this issue and the Editor's reply in "The Last Word," p 250.

Mild steel honeycomb?

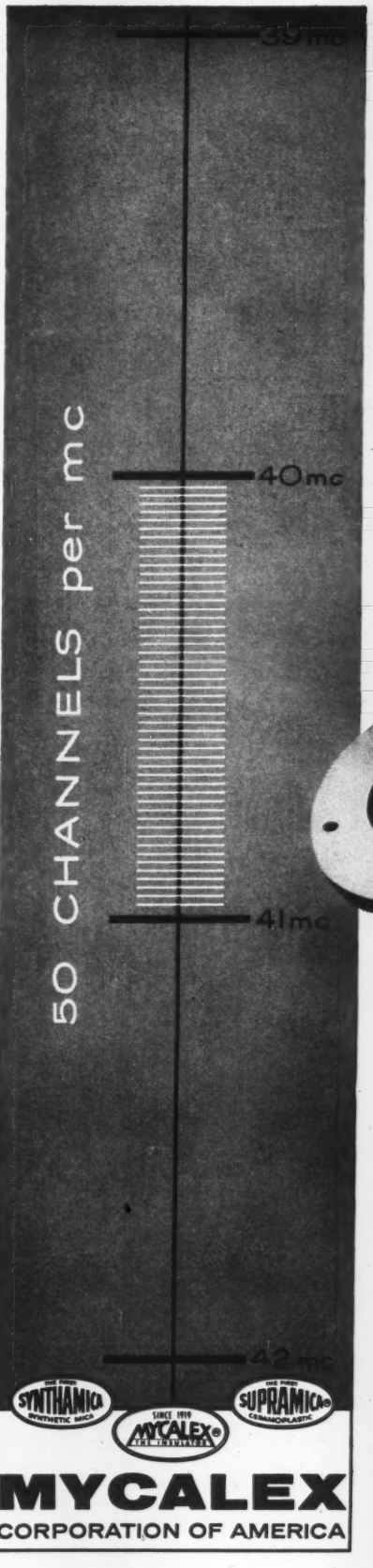
To the Editor:

This inquiry pertains to "Brazed Steel Honeycomb Structure for 800 F," Apr '59, p 110. This Command has developed techniques for the use of paper honeycomb panels to dissipate the energy of ground impact when dropping supplies by parachute. In this technique, paper honeycomb is placed on the bottom surface of the load and is crushed by ground impact. Since the material is expended in one use, it is essential that it be low cost. I believe that a mild steel honeycomb may be better and cheaper for this use than paper honeycomb.

In regard to the honeycomb cell configurations shown in the article, I would like to know whether equipment is available for forming these shapes with mild steel; and whether brazing or some other known technique may be economically utilized in bonding these shapes.

HARRY L. FREEMAN
Aerial Delivery Equipment Branch
Mechanical Engineering Div.
Quartermaster Research & Development Center
U.S. Army
Natick, Mass.

The idea seems feasible though we have no information about mild steel honeycombs. We suggest contacting the Welded Honeycomb Mfrs. Assn., 2382 Fourth St., Berkeley, Calif.



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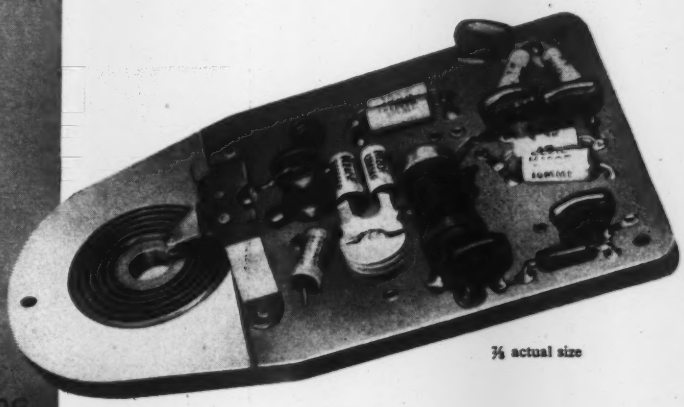

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PRICES AND SUPPLY

...AT A GLANCE

Major price cuts on medium and high density polyethylene have been announced by key producers. The most important was a 3¢-per-lb drop in the price of high density polyethylene. The cut, the second this year, brings the price down to 35¢ per lb—the current price of conventional polyethylene. The other announcement was a cut in the price of medium density polyethylene (0.093) from 42¢ to 40¢ per lb.

High purity chromium is now available in semicommercial quantities at a cost considerably below that of iodide chromium. The material, first introduced in 1958 to meet special requirements for atomic energy and high temperature alloy research, is being offered by Union Carbide Metals Co. with a total impurity level as low as 300 ppm.

More polypropylene will be available in the next few years as a result of Dow Chemical Co.'s plans to build a plant on the West Coast sometime in 1961. This supplements the company's Bay City, Mich. plant which will soon be in production.

Larger ingots of molybdenum, tungsten and other refractory metals will soon be available from Sylvania Electric Products Co. According to Sylvania, 225-lb ingots have already been produced (only 100-lb ingots have been available up to now) and larger ones are scheduled to be turned out on a recently installed 16-ton isostatic press.

Use of urethane foam continues to increase at a phenomenal rate. According to J. D. Mahoney, director of marketing at Mobay Chemical Co., urethane foams have doubled in consumption each year since their commercial introduction in 1956. Total use this year is expected to reach 75 million pounds. To keep pace with this increase, Mobay will soon boost production of tolylene diisocyanate (the major ingredient in urethane foams) from 45 to 90 million pounds per year.

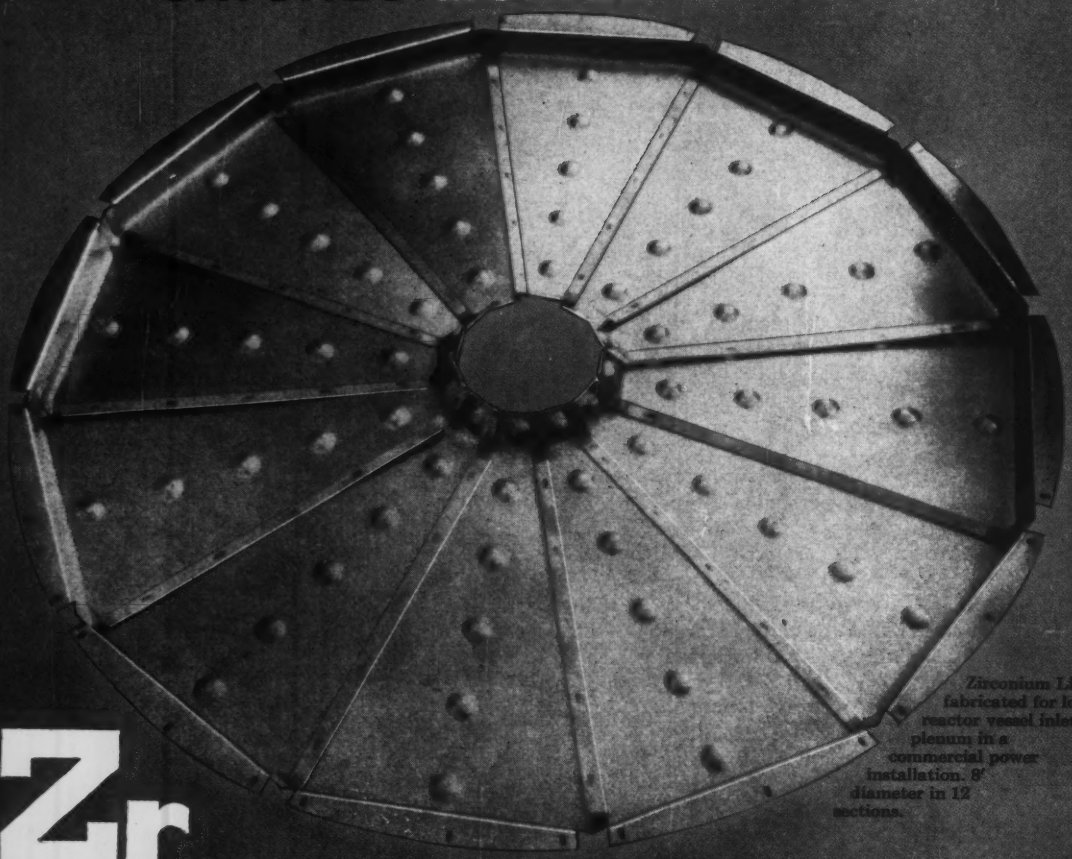
Price reductions up to 20% on ABS sheet will result from a new merchandising plan recently initiated by U. S. Rubber Co. According to the plan, 34 of the most popular sheet grades will be prepackaged and stored as "standard warehouse stocks." The packages will contain various quantities of 54 x 94-in. sheet and will be shipped within 24 hr after an order arrives.

Increased production of hydrated alumina has been announced by Reynolds Metals Co. According to the company, new equipment will enable the production of over 20 million pounds per year of the smallest particle size (1 μ). The material is used in the manufacture of plastics, catalysts, chemicals, ceramics, white rubber, etc.

More ultra pure silicon metal will be available when Monsanto Chemical Co. completes its new plant. The material, used in transistors, rectifiers and other semiconductor devices, will be produced under a license granted by Westinghouse Electric Corp. The silicon is said to contain impurities amounting to less than 1 part in 6 billion.

Greater availability of conventional polyethylene—to the tune of 70 million pounds per year—will result from Union Carbide Plastics Co.'s new plant in Whiting, Ind. According to Union Carbide, the new plant raises the company's total annual production capacity to over 400 million pounds.

CATCHES MOLTEN URANIUM



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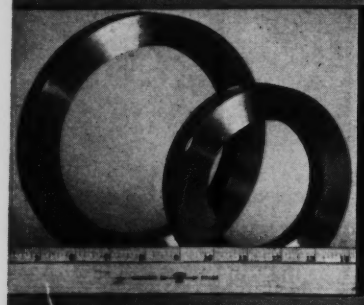

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PREVIEW

1959 Metal Show

41st National Metal Exposition and Congress, Nov 2-6

The Show

Approximately 50,000 people are expected to visit some 400 separate exhibits at Chicago's International Amphitheatre during the 41st National Metal Exposition, Nov 2-6. The theme of this year's Show is "Materials and Fabrication Preview of the Soaring '60's."

According to Clarence H. Lorig, ASM president, the show will consist of exhibits by "basic metal producers, fabricators of metals who turn these metals into the components of modern living, and scientists and engineers who push forward the frontiers of metalworking and translate discoveries and ideas into reality."

Among recent developments to be displayed are high strength steels, composite materials, super-thin stainless steel, alloy strip and vacuum melting.

Exposition hours are from 10 a.m. to 6 p.m. on Monday, Thursday and Friday, Nov 2, 5 and 6, and from noon to 10 p.m. on Tuesday and Wednesday, Nov 3 and 4. A complete list of exhibitors and their booth numbers is given on pp 25 and 27.

Chicago's river skyline

The Technical Program

This year, as last, the 41st National Metal Congress will be sponsored by the American Society for Metals in cooperation with the American Inst. of Mining, Metallurgical and Petroleum Engineers (Inst. of Metals Div., Iron and Steel Div., Extractive Metallurgy Div.); Society for Nondestructive Testing; the Metals Div. of the Special Libraries Assn.; American Society for Testing Materials; Metal Powder Industries Federation; Metal Treating Inst.; and the Ultrasonic Manufacturers Assn.

In addition to the many technical programs offered by these societies, the following special events have been planned: 1) the second Woodside Memorial Panel; 2) an ASM-Atomic Energy Commission seminar on "The Rare Earths and Related Metals"; and 3) an ASM seminar on "Resonance and Relaxation in Metals." In all, more than 275 scientific papers are scheduled to be delivered.

A condensed program covering technical sessions of ASM, AIME, SNDT and the Woodside Memorial Panel appears on p 23. Listed below are the programs of the other cooperating societies:

Wednesday, Nov 4, the Metal Powder Industries Federation will present a half-day program on powder metallurgy.

Thursday, Nov 5, the Metal Treating Inst. will present three papers on heat treating: "Heat Treatment of Gears," "How to Obtain Specified Requirements Through Heat Treating," and "Carbon Control During Heat Treatment."

Thursday, Nov 5, the Ultrasonic Mfrs. Assn. will present three papers covering the following uses for ultrasonics: joining, cleaning, hardening, welding, brazing, drilling, machining and grinding.

The program of the Metals Div. of the Special Libraries Assn. will cover two days: Thursday, Nov 5 and Friday, Nov 6. On Thursday, technical papers will be delivered by the staff of the University of Chicago's Inst. for the Study of Metals. On Friday, papers will be delivered on "Steel Strapping and Methods of Applying It to Packaging."

Program for the American Society for Testing Materials was unavailable at press time.

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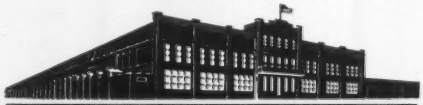
*Stanley Electric Tools, New Britain, Conn.



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STAMFORD, CONNECTICUT

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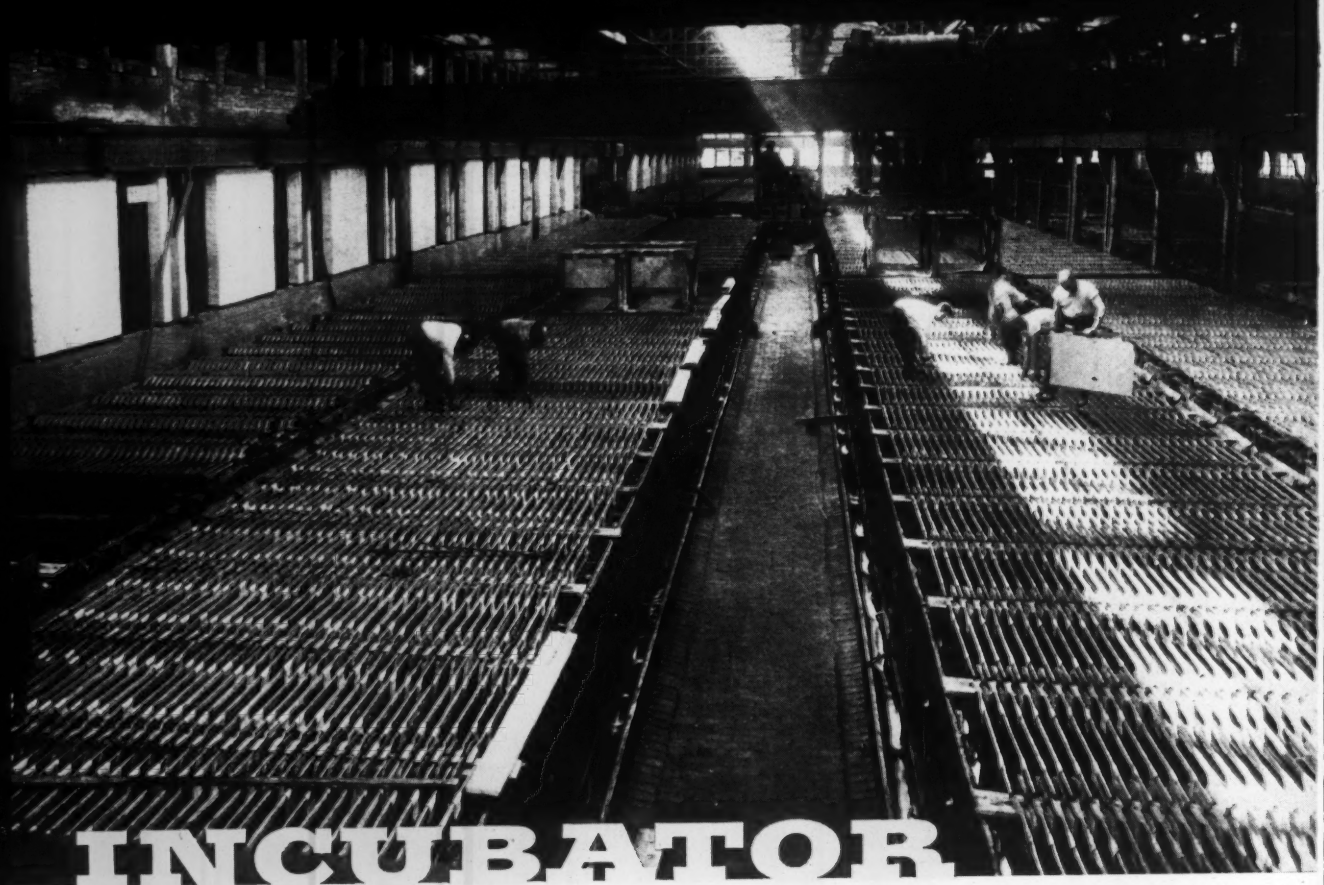
Condensed Program of Technical Sessions

41st National Metal Congress and Exposition

Society ➡	AMERICAN SOCIETY FOR METALS Hotel Sherman	WOODSIDE MEMORIAL PANEL Hotel Sherman	AMERICAN INSTITUTE OF MINING, METALLURGICAL AND PETROLEUM ENGINEERS Morrison Hotel	SOCIETY FOR NONDESTRUCTIVE TESTING Hamilton Hotel
Mon., Nov 2				
Morning	• Steel • Titanium	• Composite Materials	• Kinetics of Phase Transformations • Refractory Metals • Diffusion • Metal Processing	• New Instrumentation and Techniques
Afternoon	• High Strength Steels	• Composite Materials	• Kinetics of Phase Transformations • Refractory Metals • Creep and Fatigue • Thermodynamics and Physical Properties	• New Instrumentation and Techniques
Tues., Nov 3				
Morning	• Steel • Creep and Deformation	• Explosive Forming	• Properties of Nonmetallics • Titanium vs Steel • Steelmaking • Refractory Metals	• Nondestructive Testing Correlation with Fatigue Testing
Afternoon	• Physical Metallurgy	• Explosive Forming	• Properties of Nonmetallic • Titanium vs Steel • Steelmaking • Refining of Pure Metals	• Component Reliability
Wed., Nov 4				
Morning			• Effects of Irradiation • Metallography • Hardening • Titanium	• Nuclear Component Reliability
Afternoon	• Mechanical Working	• Refractory Metals	• Effects of Irradiation • Plasticity and Strength of Single Phases • Refractory Metals • Oxidation and Reduction	• Annual Business Meeting
Thurs., Nov 5				
Morning	• Nuclear Metals • Austenitic Alloys	• New Fabricating Techniques and Materials	• Nonferrous Melting and Casting • Recovery, Grain Growth and Textures • Imperfections • Powder Metallurgy	• Component Reliability
Afternoon	• Refractory Metals	• New Fabricating Techniques and Materials	• Nonferrous Melting and Casting • Recovery, Grain Growth and Textures • Heat Treatment and Properties of Steel • Powder Metallurgy	• Inspection of Brazed Honeycomb Structures
Fri., Nov 6				
Morning				• Educational Clinic
Afternoon				• Educational Clinic



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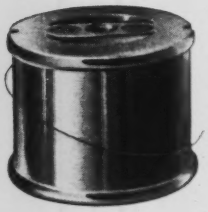
TYPE OF CLAD WIRE	DESCRIPTION	PROPERTIES
SEALING WIRES		
52 Alloy Clad Copper	Soft-glass sealing material for lead-in wires of electronic tubes, semiconductor devices and lamps.	Coeff. of exp. 102 x 10^{-7} in./in./°C
Dumet Copper Clad 42 Alloy	" " "	Coeff. of exp. 11.7 x 10^{-6} in./in./°C
Kovar Clad Copper	Hard-glass sealing material for lead-in wires for hermetically sealed electrical and electronic products.	Coeff. of exp. 60 x 10^{-7} in./in./°C
SPECIAL		
Copperweld Copper Clad Steel	High-conductivity, high-strength material for grid side rods in electronic tubes.	Resistivity 27.0 ohms/cir. mil ft. @ 68°F
Kulgrid® 64 Nickel Clad Copper	High-temperature conductor extensively used for aircraft spark plug electrodes.	
HIGH-TEMPERATURE CONDUCTORS		
Aluminum Clad Copper	Resistivity—13.0 ohms/cir. mil ft. @ 68°F	Operating range—up to 800°F
Kulgrid® 28 Nickel Clad Copper	Resistivity—13.85 ohms/cir. mil ft. @ 68°F	Operating range—up to 1000°F
Inconel Clad Copper	Resistivity—14.6 ohms/cir. mil ft. @ 68°F	Operating range—up to 1100°F
Oxalloy® 28 Stainless Steel Clad Copper	Resistivity—16.0 ohms/cir. mil ft. @ 68°F	Operating range—up to 1300°F
Nickel Clad Silver	Resistivity—11.3 ohms/cir. mil ft. @ 68°F	Operating range—up to 1500°F

°Trade Mark

SYLVANIA offers the most complete line of CLAD WIRES



Sylvania Clad Wires are in increasing demand in electrical and electronic manufacturing where single-metal or one-alloy wires cannot meet the requirements . . . particularly in high-stress, high-temperature, high-conductivity applications.

Unlike plating, the Sylvania cladding process literally slips a tube of one metal over a rod of another metal and draws them out together into a wire combining the qualities of both metals. These wires maintain exact ratios of core material to cladding material . . . each can be held to as little as 10% or as much as 90% of the finished wire.

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Plated Metal Strip
Electronic Components
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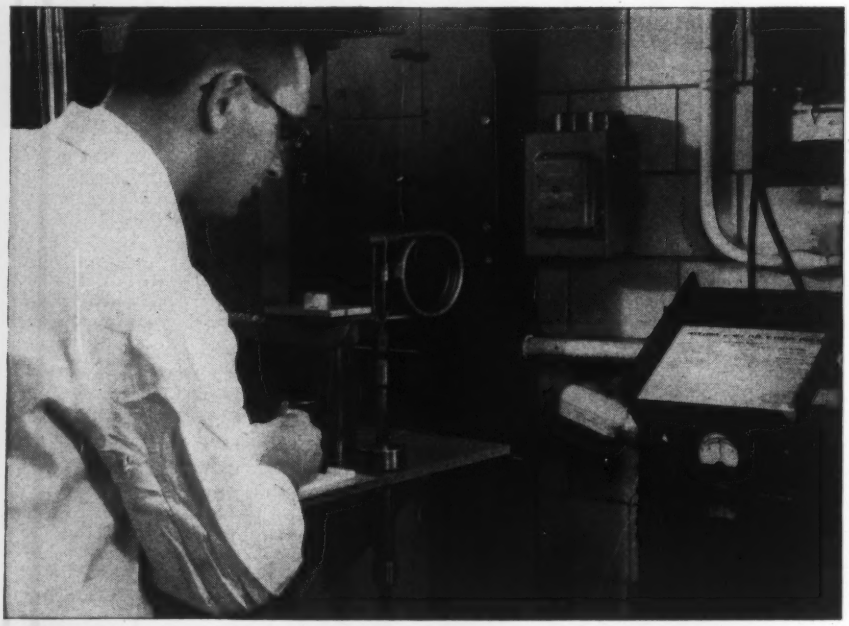
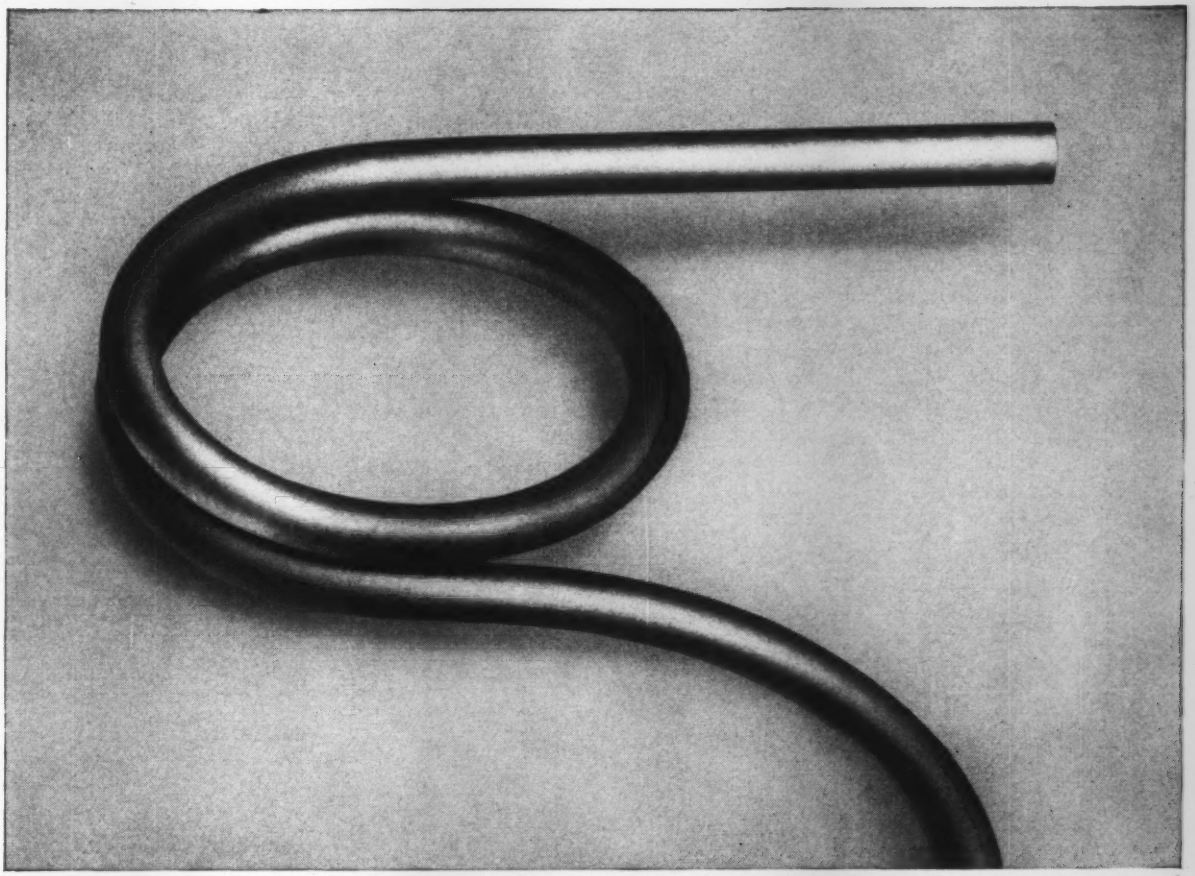
20,000 chairs rock on USS American Springs without one failure

...thanks to AS&W

In the American Steel & Wire Spring Testing Laboratory, the springs recommended for the Homecrest Chair go through extensive tests. This Fatigue machine, by means of strain-gauge verification, simulates years of use in a relatively short testing time.





Here is the spring recommended by American Steel & Wire for use in this chair. To supplement the AS&W tests, the Homecrest Company subjected these springs to a simulated rocking test. Under a weight of 250 pounds, these springs were rocked 750,000 times, without failure.

Spring Engineering Research Service

The Homecrest Company, Wadena, Minnesota, wanted to add a swivel rocking chair to their line of modern, functional home furniture. However, they would produce this chair only if it could be a quality item that would give good, dependable service. While designing the chair, they checked with the American Steel & Wire Spring Engineering Consulting Service. The engineers studied the problem, ran extensive tests and finally recommended a pair of round wire helical single coil torsion springs. Using these springs, Homecrest designed, fabricated and marketed the chair. Today 20,000 of these chairs have been sold and not one failure of an AS&W Spring has been reported.

Mr. A. L. Englemann, a partner of Homecrest Company, says, "We have purchased from American Steel & Wire over 45,000 springs, and not one has been reported a failure. We couldn't be happier with American Steel & Wire as a supply source for our springs."

If you have a spring problem, or would like advice on the use of springs in your product, get in touch with any American Steel & Wire Sales Office. You can benefit from the knowledge of AS&W's Spring Engineering Research Service. The Service has been engaged in laboratory experiments of static and dynamic testing for 20 years and has accumulated invaluable data on stress and fatigue life of steel springs, while endeavoring to improve efficiency in the use of steels, from steel chemistry through product application, to more economically cope with today's rigorous demands. This accumulated knowledge of the AS&W Spring Engineering Research Service is at your disposal. *American Steel & Wire, 614 Superior Ave., N.W., Cleveland 13, Ohio.*

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Another Tinnerman Original...

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Wherever you require a heavy-duty, multi-thread, self-retaining fastener, a Tinnerman SPEED GRIP Nut Retainer answers the need, holds down assembly costs.

SPEED GRIPS snap into place... some into panel holes... others over panel edges. No special tools or skills required. Spring-steel fingers grip the panel, yet let the nut float to compensate for normal panel-hole misalignment. Welding, staking and clinching are eliminated. SPEED GRIPS can even be applied after panels have been finished, avoiding paint-clogged threads.

SPEED GRIPS are available in a wide range of sizes and types, including front-mounting nut and bolt retainers for hard-to-reach or blind locations.

See your Sweet's Product Design File, section 8-T for data on these and other SPEED NUT Brand Fasteners. Your Tinnerman representative has complete information and samples. If he isn't listed under "Fasteners" in your Yellow Pages, write to:

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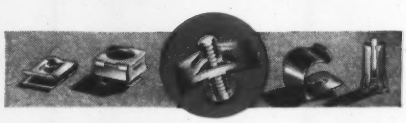


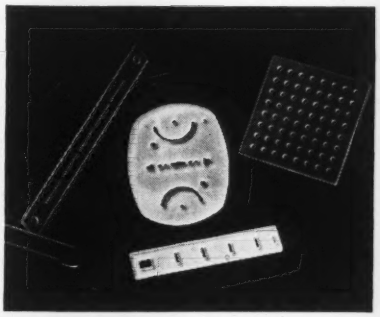
FASTEST THING IN FASTENINGS®

CANADA: Dominion Fasteners Ltd., Hamilton, Ontario. GREAT BRITAIN: Simmonds Aerocessories Ltd., Treforest, Wales. FRANCE: Simmonds S. A., 3 rue Salomon de Rothschild, Suresnes (Seine). GERMANY: Mecano-Bundy GmbH, Heidelberg.

For more information, turn to Reader Service card, circle No. 459

THIS IS GLASS

A BULLETIN OF PRACTICAL NEW IDEAS FROM CORNING



CONCERNING PRECISION AND PHOTOSENSITIVE GLASS

Pure precision, in any form you like . . . how? With photosensitive glass!

What could be more precise than present-day photography? What more precise than "chemical etching" which works discretely on the molecular level and does away with the variables that invariably follow such operations as grinding, drilling, cutting and engraving?

What, indeed, when we can put exactly 250,000 holes on a plate only an inch square! Each of the holes can be *precisely* the same as its 249,999 companions; they can be square or even triangular. A change in size, shape or number of holes requires only a change in negative.

Such precision is not a drawing board dream. People are *using* photosensitive glass right now: for fine-mesh 500-line screen, for brush holders for digital computers, for various substrates, for printed circuits, for micro-module wafers, for attenuator plates, for dielectric spacers and for evaporation marks.

For more details, send the coupon for a copy of our bulletin on FOTOFORM® glasses.

GOOD HOUSEKEEPING

If you have 2″ x 2″ light filters, are not quite happy with your facilities to store them, and would like to correct the situation, read on.

For only ten dollars we offer this compact kit of four sturdy boxes which were just *made* for holding filters. There's room for eighty filters to rest safely in slotted softwood. The boxes are covered in good-looking, long-wearing buckram.

If you'd like some fresh filters to put in the files, we have a complete set, or any part thereof, available. For three hundred and sixty dollars we'll send you the complete set of sixty-seven, including:

6 ultraviolet-transmitting, clear filters
6 ultraviolet-transmitting, visible absorbing
7 blue
7 blue-green
6 green
18 sharp cut
5 yellow
8 infrared
4 miscellaneous

We are not averse to splitting these sets if you have specialized wants. We can also provide 3⅛″ x 6½″ squares of those same filters, but without the box.

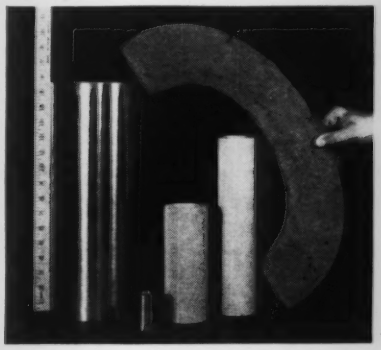
For more information on both box and filters, check the coupon.

TOO PURE TO TOUCH? "AIRLIFT" YOUR PRODUCT.

Molten metal slips down a chute without ever actually touching the chute.

Film and foil flash by over rollers without even touching them.

Tricks like these are accomplished with chutes and rollers made from a relatively new kind of nickel*—with pores in it. Air or some other gas is forced through these pores, and a cushion of gas forms to gentle products along, without a touch of contamination or scratches.



We make the porous nickel in tubes, cylinders, hemicylinders, and flat sheets up to 24″ long. We add holes or projections without secondary finishing. We do any machining needed.

Pores run with a high degree of uniformity in diameters from 1 to 45 microns, depending on space. Yield strength is a full 20,000 psi. Maximum working temperature is 300° C.

We welcome your questions, your specs, your orders.

***Of course, we realize that nickel is far removed from glass, but we figure that the people who read "This Is Glass" are the very people who will be interested in porous nickel.**

CORNING MEANS RESEARCH IN GLASS

CORNING GLASS WORKS 50-10 Crystal St., Corning, N.Y.

Please rush along: ☐ Information on color filters ☐ Bulletin on FOTOFORM Glass ☐ Data on porous nickel and also _____

Name _____ Title _____

Company _____

Street _____

City _____ Zone ____ State _____

For more information, turn to Reader Service card, circle No. 423

TONKA TOYS get extra sales play with "playproof" Du Pont DULUX® Enamel

- Gleaming finish and structural stamina are responsible for wide trade and consumer acceptance
- Development and operation of high-speed finishing line typifies successful Du Pont-customer relationship

The eye appeal and durability of gleaming "Dulux" Enamel have helped Tonka Toys of Mound, Minnesota, become one of the country's leading manufacturers of metal toys. "Dulux" itself, the way in which it is applied, and the close cooperation between Tonka and Du Pont personnel have all contributed to the end result.

"We are immensely impressed with the caliber of Du Pont technical service and the performance of 'Dulux'," says L. E. Baker, president. "Our association has produced a highly efficient production line giving the desired quality appearance and durable finish to our toys."

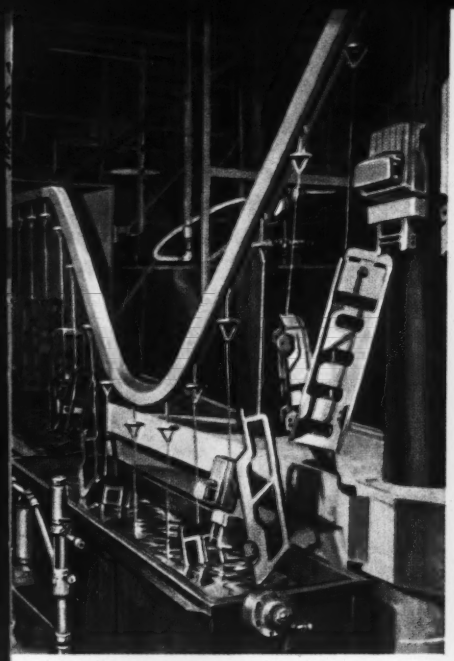
Like Tonka Toys, most manufacturers can benefit by augmenting their own staffs with the kind of experienced personnel Du Pont offers to users of industrial finishes. A depth of experience is available from technically trained Du Pont salesmen and service men, from field service laboratories, from plants and plant laboratories, and from the world's foremost paint research laboratory.

Du Pont specialists have experience in all industry classifications and in all methods of application of finishes. They can recommend systems most likely to solve finishing problems, formulate products to function in those systems, and work on a continuing basis with customer personnel to maintain peak production-line efficiency. *They can help you develop better finishing at lower costs.*

If finishing is an essential part of your production, it will probably pay to call in a representative of Du Pont Industrial Finishes, E. I. du Pont de Nemours & Co. (Inc.), Wilmington 98, Delaware.

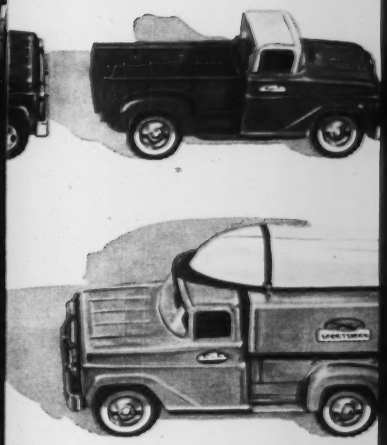
DIRECT HIT—but "Dulux" stands up to impact of mallet without cracking or chipping. In this assembly-line operation, plastic windshields are secured by a sharp blow on top of the truck cab.

Du Pont Finishes Service Package—**FORMULATION, APPLICATION,**

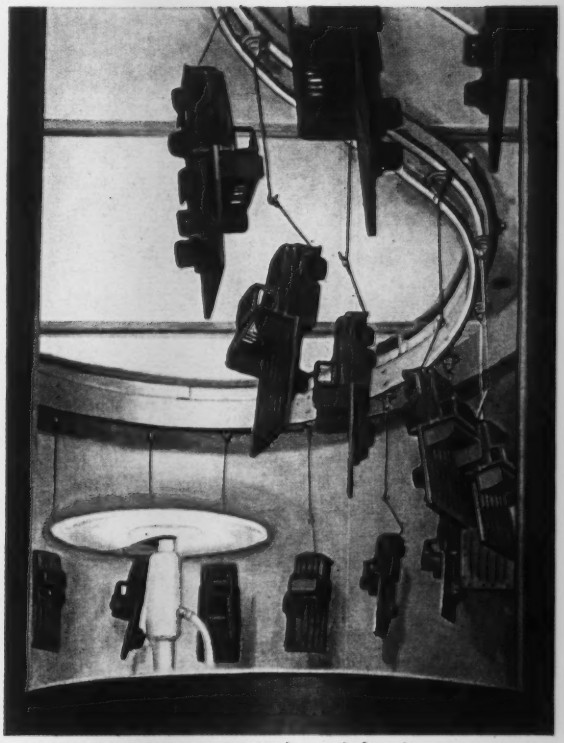


HIGH-SPEED DIPPING with "Dulux" finishes intricate toy components inside and out. Du Pont service men make frequent calls to check all phases of the finishing operations with production personnel. Over 38,000 toy components are painted daily by dipping or spraying with "Dulux".

HAND SPRAYING coats the simpler toy components during peak production periods. Here C. M. Groschen, plant manager (right), and G. W. Giles, Du Pont technical service, discuss paint viscosities for spraying. Refinements in finishing techniques have resulted from such teamwork.



CLOSE COOPERATION IS KEY to success at Tonka Toys. Above, R. L. Wenkstern, vice president in charge of production, points out a design feature to L. E. Baker, president (far right), C. L. Melka, Du Pont salesman (standing), and S. A. Beckstrom, purchasing agent. Solutions to many finishing problems result from such poolings of talent between Du Pont and customers.



ELECTROSTATIC SPRAYING is used for the top coat. A whirling disk flings fine, negatively charged paint spray onto positively charged toy components on conveyor line. Advantages: extra paint thickness on toy exteriors, better appearance. Du Pont recommended installation of this unit . . . developed paint formulations for it . . . helped train operating personnel.

FOLLOW-THROUGH—*Sets Today's Production Pace*

DU PONT
REG. U.S. PAT. OFF.

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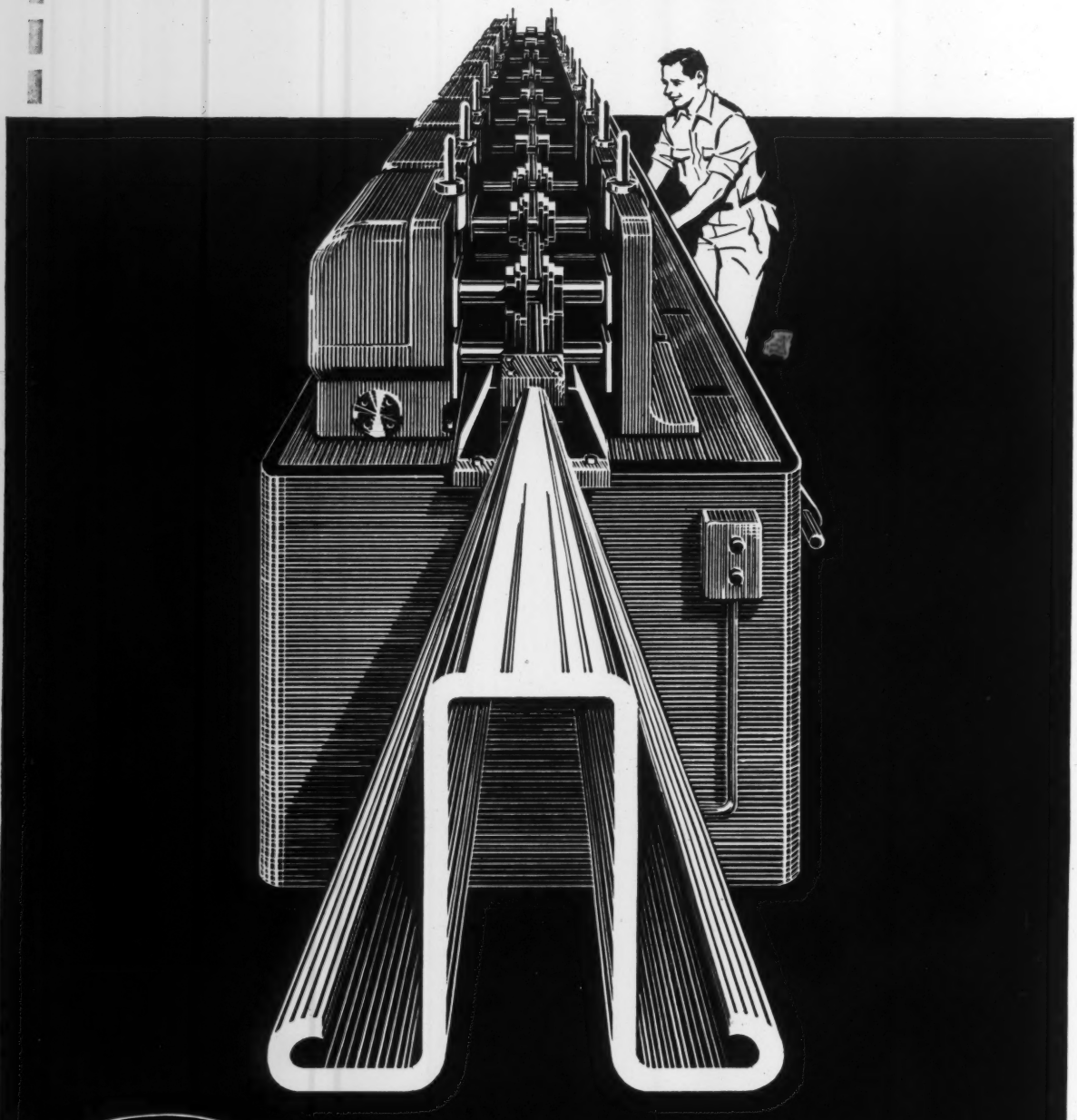

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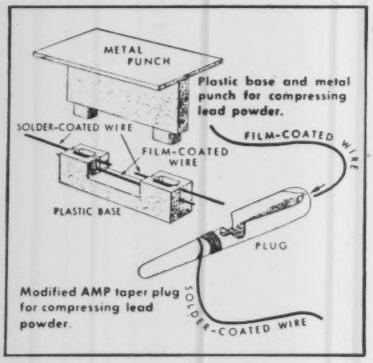
for architecture

the LEAD newsletter

Only the imagination seems to limit the modern uses for lead and its compounds. This versatile material – well known to the ancient world – is finding hundreds of new uses today. Lead has many truly unique qualities that recommend it for use in applications that range from fine china to atomic rockets. Here are a few of the important jobs Lead is doing today – and the reason why Lead was selected.

Livelier Colors For Spandrelite

Lead-bearing glass color enamels are an important factor in the brilliant color palette of Pittsburgh Plate Glass Company's Spandrelite. This structural plate glass product is produced in a wide variety of jewel-like tones that range from pastels to chartones. These uniform colors are permanently fused into the glass and will not fade with time. Spandrelite is exceptionally corrosion-resistant, non-absorbent, stainproof, and is easily cleaned. These glass enamels are based on the excellent fluxing properties of lead compounds, which make possible livelier colors than any other flux. Lead also contributes low surface tension and low interfacial tension properties to the enamels on glass.



Superconductivity

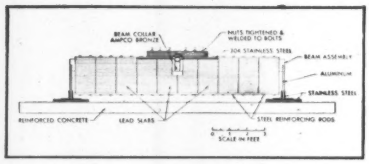
The superconductive phenomena of lead have not yet been fully exploited, but International Business Machine Corporation has successfully used lead for making superconducting connections to thin films of vapor-deposited metal in cryogenic circuits. Lead has a high critical field, and does not switch into the normal state by self-field when a gate strip of tin switches. It is economical and readily available in the purity and type desired . . . vaporizes easily so that flat film cryotrons can be made up by vacuum evaporation techniques. No heat and only moderate pressure are required when lead is used in powder form to make connections of the type used by IBM. Lead's normally high resistivity coupled with the superconducting transition makes lead and certain lead alloys very attractive and worth investigating.

Lead Braze Alloy Improves Quality, Lowers Cost In Joining Ceramic Metal Seals

Lead base solders are finding extensive use in electronic and metallurgical applications. The Research Laboratories of Sylvania Electric Products, Inc. recently demonstrated lead's versatility in joining by producing these ceramic-metal seals, useful up to working temperatures of about 300°C. The braze alloy can be used in either powder, sheet or wire form. No auxiliary flux is required to promote the bond, and a mechanically strong, completely hermetic seal is obtained. The lead braze is non-strippable, and has a higher breakdown strength that gives it both a quality as well as a cost advantage over other low cost commercial ceramic-metal sealing products.

Industrial Trucks Powered By Lead-Acid Batteries Prove Their Worth

Industrial trucks powered by lead-acid batteries are transporting all types of industrial products at comparable speeds – and doing it more economically – than other types of powered trucks. A recent analysis showed the following reductions in fleet operating and maintenance costs: 50% for fuel, 75% for maintenance parts and 60% for maintenance labor. Where 6 to 8 men were formerly needed to service and maintain the gas-powered fleet, the



equivalent of 3 men now handle the battery-powered fleet. Another example of lead's versatility and economy!

Lead Controls Vibration In "White Noise Room"

Lead – 592 slabs weighing 25 tons – is used in the "White Noise Room" of Minneapolis-Honeywell Regulator Company's Inertial Guidance Center as a damping mass to confine vibration and noise to the test area and to dissipate energy. "White Noise" is so called because it includes several frequencies of the noise spectrum, just as white light is a blend of several frequencies of the light spectrum. Here, researchers exactly duplicate the vibrations and mechanical noise produced by a missile or space ship in order to investigate the effects of vibration on the drift rate of gyros and accelerometers. In addition to minimizing vibration, lead is non-ferromagnetic, and eliminates any magnetic field disturbances that could interfere with other work in the area.

Lead Keeps Pace

Lead compounds are remarkably able to keep pace with changing technology. They are very much the subject of continued scientific attention, and L.I.A. researchers are constantly investigating new uses, new techniques to keep lead ahead.

If you would like information or technical assistance on a new product – or problem – where lead's unusual capabilities may be put to good use, please let us know. Write to: *Office of Technical Information, Lead Industries Association, 60 East 42nd Street, New York 17, N.Y.*

1971

LOOK AHEAD WITH LEAD

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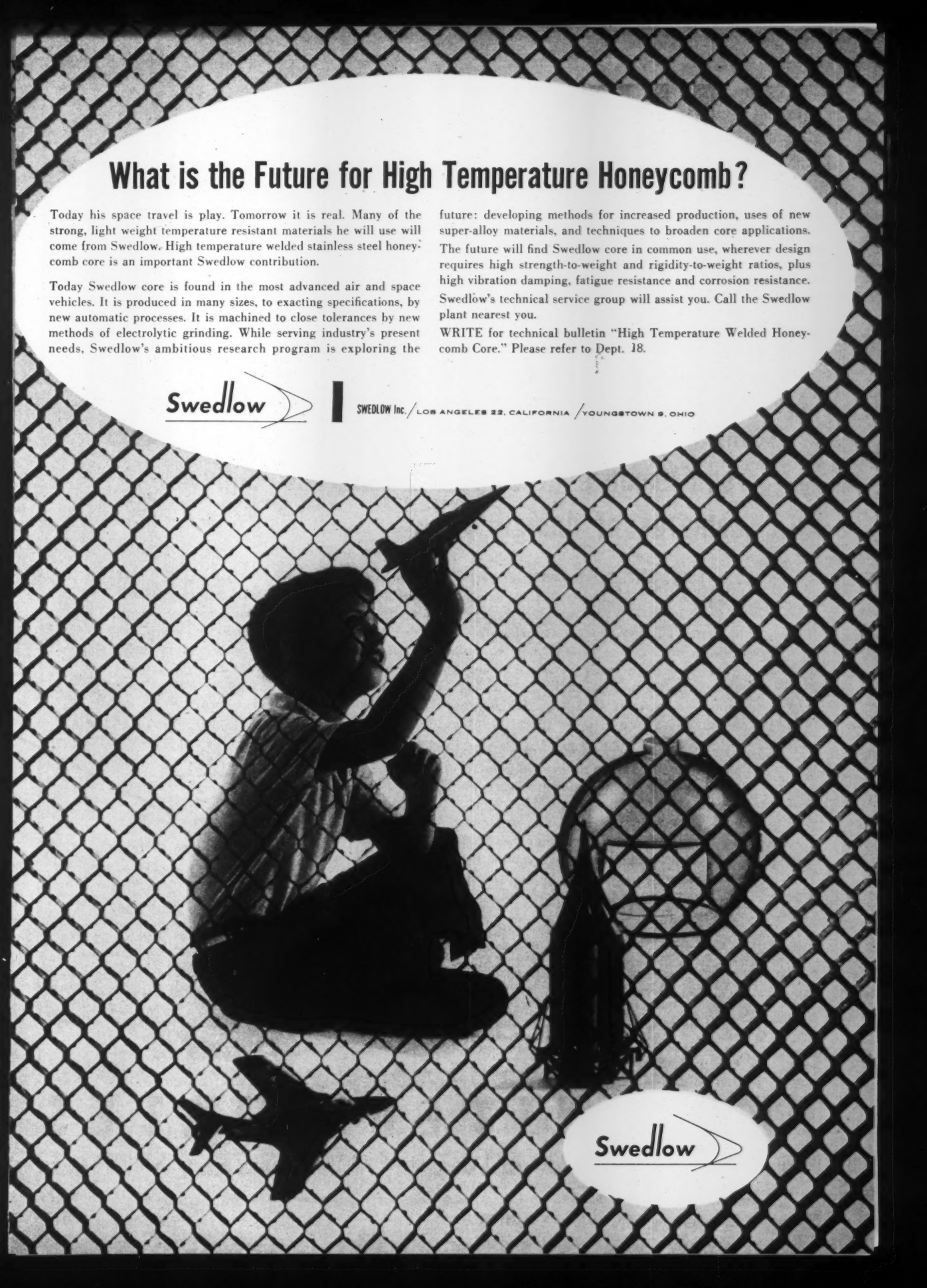

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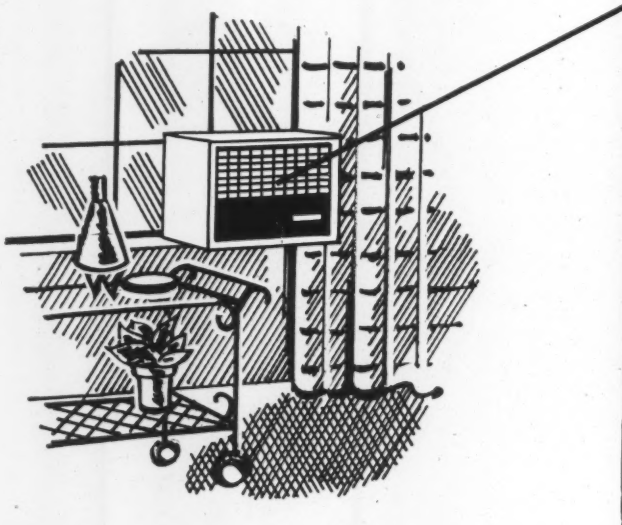

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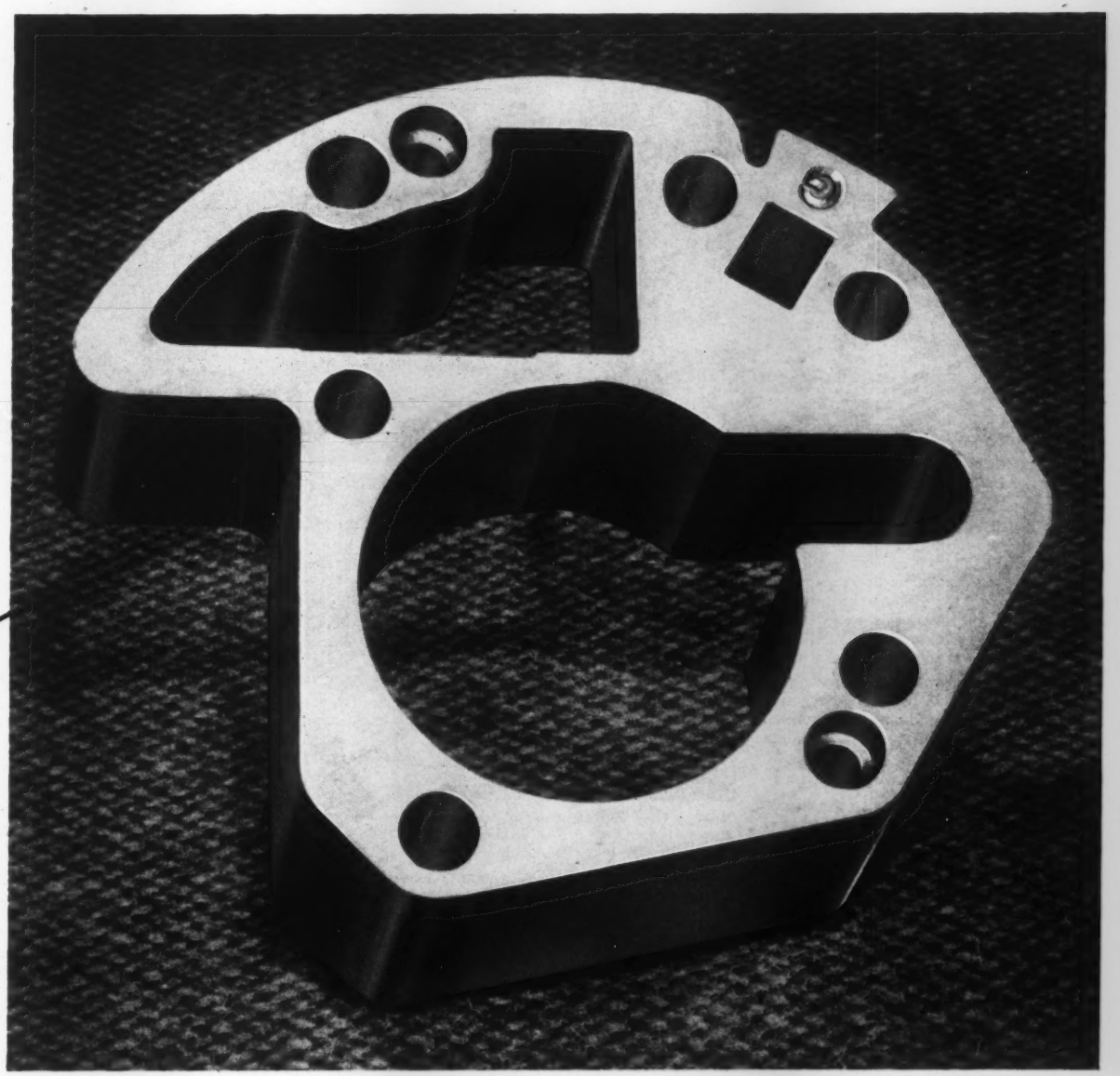
GRAPHITAR® CARBON-GRAPHITE • **GRAMIX®** POWDER METALLURGY • **MEXICAN®** GRAPHITE PRODUCTS • **USG®** BRUSHES

IS VITAL PART IN



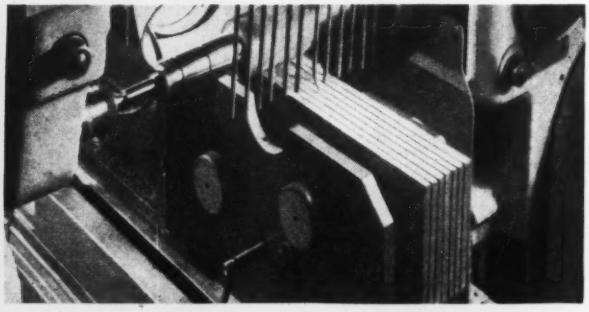
This part is shown 1½ times size. Actual weight: 2¼ lbs. X-271-2

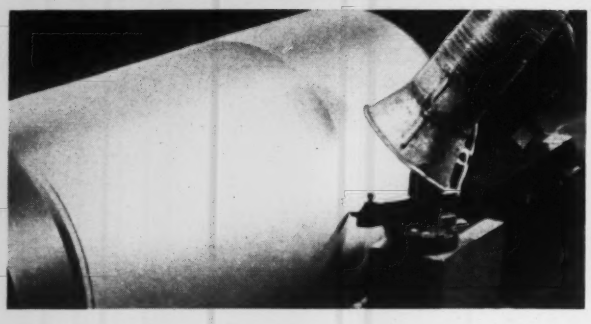
GRAPHITE COMPANY

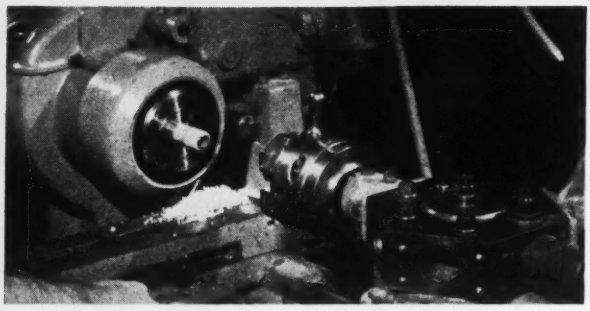
DIVISION OF THE WICKES CORPORATION, SAGINAW 3, MICHIGAN

For more information, turn to Reader Service card, circle No. 516

To all the combined advantages of Synthane Laminated Plastics . . . add one more big plus—**MACHINABILITY**







There are many reasons why plastic laminates such as Synthane are well regarded. They offer—in combination—resistance to heat, wear, chemicals, oil, water; light weight; excellent dielectric properties and mechanical strength; dimensional stability. On top of all these, however, is the one property that makes Synthane practical—Machinability.

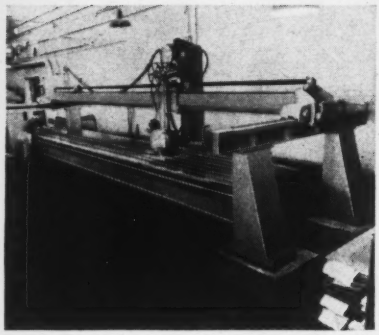
This means that whatever your application you may obtain parts of Synthane in the form desired and at a reasonable cost whether you require one or a million.

How Machinable is Synthane?

Synthane laminates are easy to machine, using ordinary wood or metal working machinery with only a few modifications of method. As an example, here are some standard machining operations readily performed on Synthane:

Shearing	Screw Machine Operations
Band Sawing	Planing
Circular Sawing	Shaping
Drilling	Punching
Tapping	Broaching
Fly cutting	Shaving
Milling	Sanding
Gear cutting	Grinding
Turning	Boring
Turret Lathe Operations	Tumbling
	Buffing

Practically all of these operations can be handled on standard machines, many with standard cutters. But the nature of the material, being softer and more resilient than metal, and being laminated and a poor heat conductor, often makes the use of cutters with special rake and clearance, operating at special feeds and speeds, desirable.



Sawing long lengths. One of the numerous special tools whose advantages are available when Synthane fabricates the material.

The successful machining of Synthane laminates is aided by proper design of parts for ease of machining. A Synthane booklet: "Design Hints for Laminated Plastics*" adequately covers design recommendations.

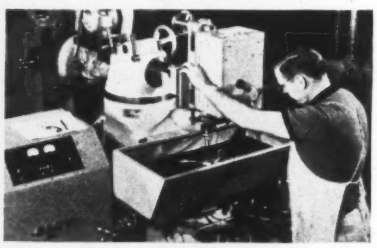
It pays to let Synthane machine laminated plastics for you

Although Synthane laminated plastics are easy to machine, it will usually pay you to have us handle the machining for you—for these reasons:

1. All of our equipment is especially designed or adapted for the fabrication of plastics.
2. We are constantly developing new, faster, and more economical methods of machining Synthane laminated.
3. We make all of our own tools, dies, fixtures and jigs, quickly and economically.
4. We relieve you of all production worries: machining errors, rejects, waste, mistakes in dimensions or tolerances, and delays in delivery.
5. Because we combine manufacturing and fabrication in one location, we can maintain high quality control while solving difficult machining problems. When necessary, we can even modify the properties of a given grade of material to meet special requirements.

For further information, write Synthane Corporation, 3 River Rd., Oaks, Penna.

**Booklet available upon request.*



Metal disintegration, a fast, economical way Synthane uses to produce or revise dies.

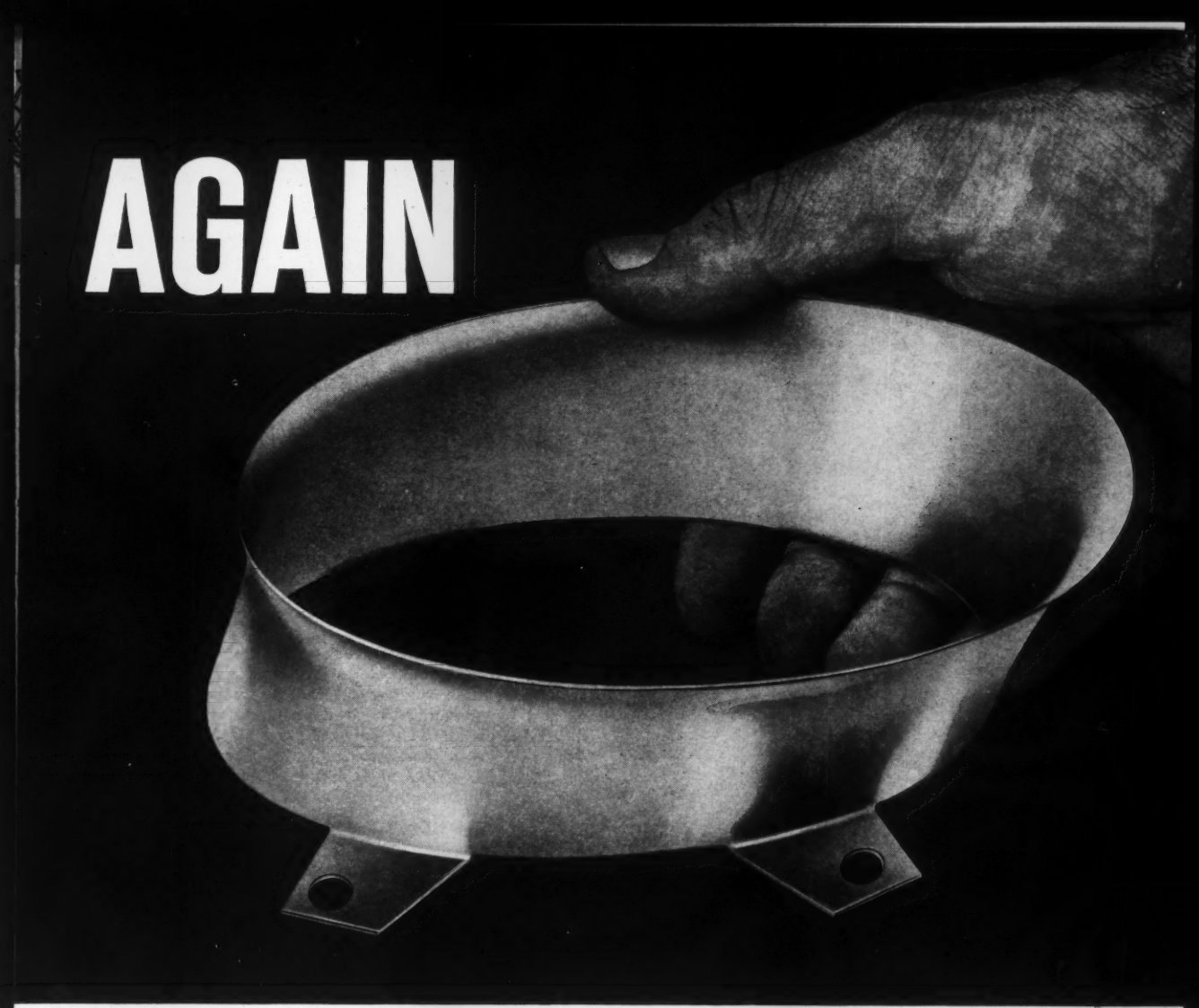
SYNTHANE

CORPORATION, OAKS, PENNA.

Laminated Plastics for Industry

Sheets, Rods, Tubes, Fabricated Parts
Molded-laminated, Molded-macerated

For more information, turn to Reader Service Card, circle No. 378



Revere helps "fit the metal to the job"

AND A MAKER OF FINE CARS SAVES MONEY WHILE IMPROVING PRODUCT QUALITY

Recently, a manufacturer of top-flight motor cars was having trouble in producing the above escutcheon for the front bumper lamps used on his newest model.

First of all, the breakage of the part was excessively high. Second, the escutcheon which is drawn at an angle, and contains a concave surface on the inside presented a problem in that, after buffing, polishing, and flash plating, the finish produced did not exactly match the chrome-plated bumper.

Revere's Technical Advisory Service suggested these difficulties might be overcome by using Revere 70-30 Brass Strip.

Here, again, by "fitting the metal to the job" Revere's Technical Advisory Service was able to reduce manufacturing costs while improving the quality of the product. Finish of parts was improved while finishing costs were reduced. Finished parts proved an excellent match. Switching to the more ductile metal resulted in less tool wear, while breakage was reduced to less than 1%. All this with little adjustment of existing press equipment.

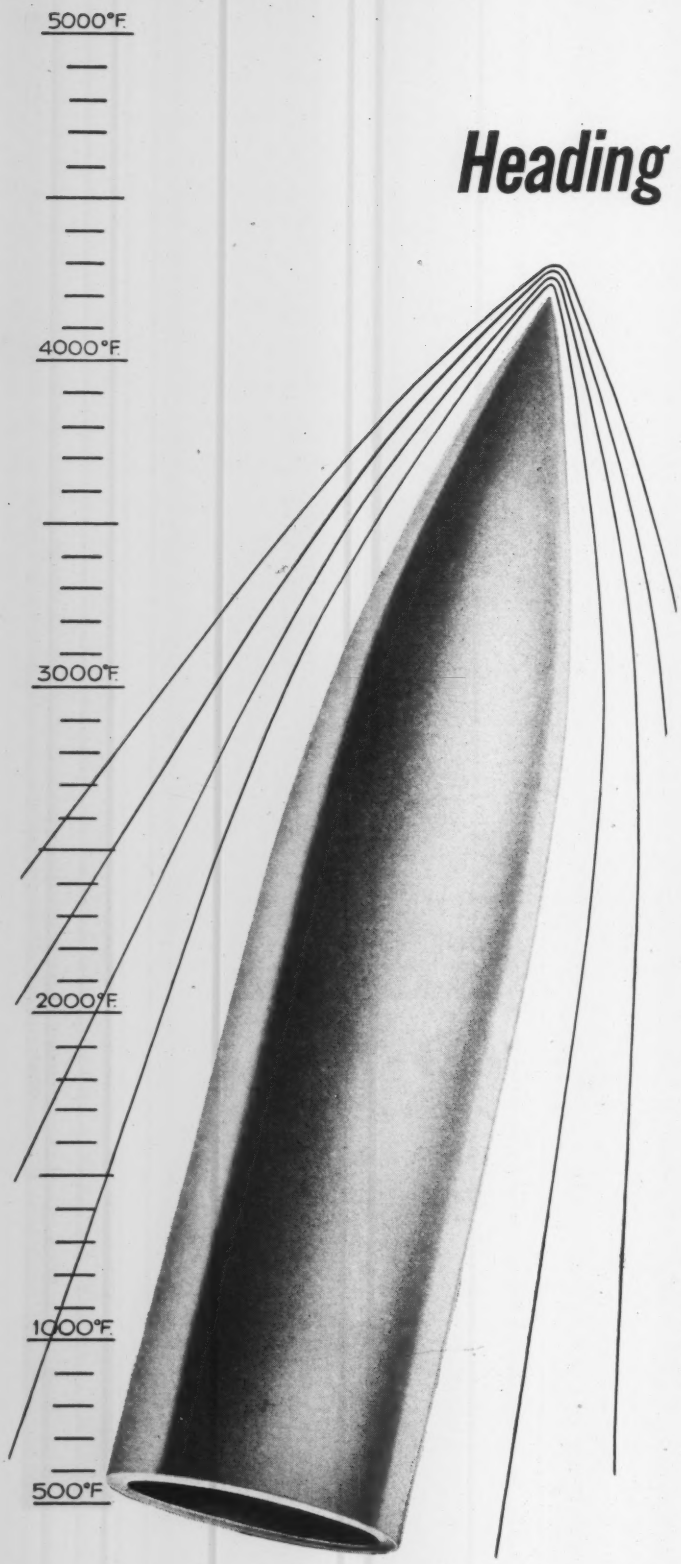
Why not consult with Revere's Technical Advisory Service and take advantage of its extensive knowledge in "fitting the metal to the job." This Service has saved others money, why not you?

REVERE COPPER AND BRASS INCORPORATED

Founded by Paul Revere in 1801
230 Park Avenue, New York 17, N. Y.

Mills: Rome, N.Y.; Baltimore, Md.; Chicago, Clinton and Joliet, Ill.; Detroit, Mich.; Los Angeles and Riverside, Calif.; New Bedford, Mass.; Brooklyn, N.Y.; Newport, Ark.; Ft. Calhoun, Neb. Sales Offices in Principal Cities. Distributors Everywhere.

For more information, turn to Reader Service card, circle No. 496



Heading for the unknown?

Check your processing requirements against Norton Fused Zirconia

You can't predict tomorrow's processing requirements. However, you can be prepared to meet many of them more efficiently and economically . . . with Norton *Lime-Stabilized* Fused Zirconia.

Consider Its Unusual Characteristics

Extremely high melting point (4,620°F) coupled with a lower thermal conductivity than standard dense refractories • Excellent resistance to thermal shock and abrasion • Not wet by most metals • Moderate electrical insulator at low temperatures and conductor above 2,200°F • Good stability in either oxidizing or reducing atmospheres.

Consider Its Many Applications

As potential material for use in missiles and reaction motors • As a support for firing highly-reactive titanates • As lining for furnaces containing high temperature gaseous reactions • For furnace parts and linings used in the metals industry • As lining and packing media for high temperature air heaters and heat exchangers • For many other critical processes.

Chances are you can improve both your processing and your production economy with this rugged, versatile material. Let a Norton Sales Engineer help. He's well qualified to discuss your precise requirements. Write to NORTON COMPANY, Refractories Division, 349 New Bond Street, Worcester 6, Mass.

Note: Norton *Lime-Free* Fused Zirconia is also available for the manufacture of refractories, as a source material for zirconium for chemicals and metals, or as an opacifier for glazes and enamels.

Melting Point	4,620°F
Maximum Usable Temperature	4,450°F
Chemical Nature	Stable
Electrical Resistivity	High Temperature Conductor
True Specific Gravity	5.6 — 5.7
Two Grain Types	Hard Dense Grains
	Bubble-Type Grains

NORTON
REFRACTORIES
Engineered . . . Rx . . . Prescribed

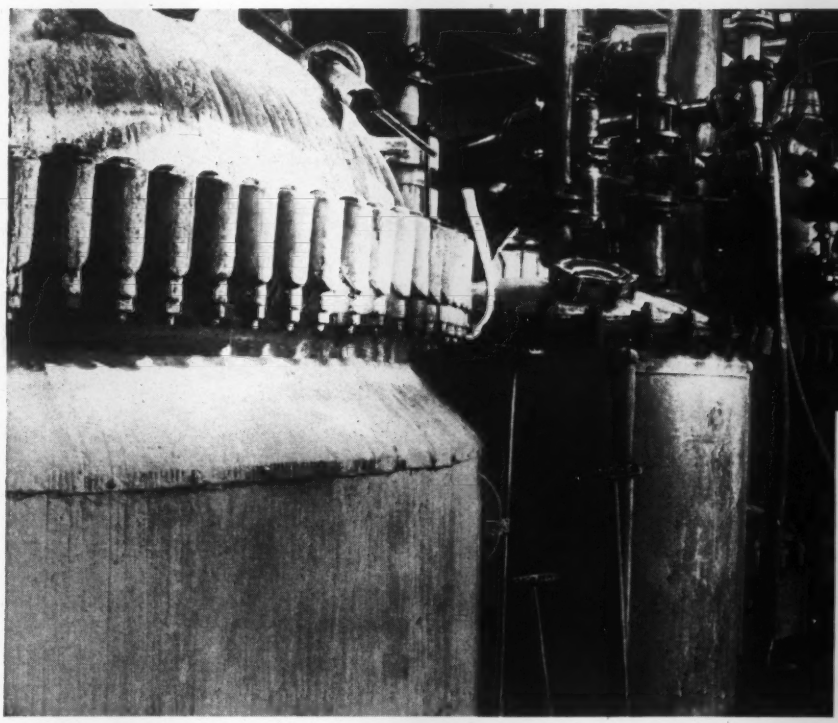
Making better products . . . to make your products better

NORTON PRODUCTS Abrasives • Grinding Wheels • Grinding Machines • Refractories • Electrochemicals — **BEHR-MANNING DIVISION** Coated Abrasives • Sharpening Stones • Pressure-Sensitive Tapes

For more information, turn to Reader Service card, circle No. 390

Witco Plant Controls Bring You The Most Uniform

RESINS FOR URETHANE FOAMS



Why do more and more manufacturers turn to Fomrez® resins for rigid and flexible urethane foam production?

Because WITCO FOMREZ resins assure batch-to-batch uniformity of your foam production. Their easy handling characteristics and high reproducibility reduce your production budget.

There's no compromise on quality with Witco. Up-to-date instrumentation guards high manufacturing standards. Quality is controlled at every production stage.

Send today for details of Witco Fomrez Resins. Just fill out and mail the coupon.

FOR FLEXIBLE FOAMS: *Fomrez 50 and Fomrez 70* • For use in furniture cushioning and upholstering; automotive seating, crash pads and headliners; garment interliners and shoulder pads.

FOR RIGID FOAMS: *Fomrez R-400 and Fomrez P-420* • A prepolymer foaming system for carbon dioxide or Freon blowing. Used in refrigerators and other cold-storage equipment; for structural reinforcement in sandwich panel construction; vibration dampening in aircraft and automobiles; marine flotation; and potting compounds.

WITCO CHEMICAL COMPANY, Inc.
122 East 42nd Street • New York 17, N. Y.
(Dept. MDE-10)

I am interested in: ☐ Fomrez 50 and Fomrez 70 for flexible foams
☐ Fomrez R-400 and Fomrez P-420 for rigid foams

Please send ☐ literature ☐ sample. The application I have in mind is_____

Name_____ Title_____

Company_____

Address_____

City_____ Zone___ State_____

WITCO CHEMICAL COMPANY, Inc. • 122 East 42nd Street, New York 17, N. Y.
Chicago • Boston • Akron • Atlanta • Houston • Los Angeles • San Francisco
Montreal and Toronto, Canada (P. N. Soden & Co. Ltd.) • London and Manchester, England

For more information, turn to Reader Service card, circle No. 410

DOW | **7 NEW IDEAS IN 7 MINUTES**

It takes two things to make the cash register ring today: New ideas—products that people really want—and new materials to make those ideas work. Many of these are plastics materials such as the large, widely diverse line of Dow thermoplastics. These chemically engineered materials give the product designer more latitude and the production man fewer headaches. Sales managers like them, too, because they contribute beauty, durability and *quality* in no small measure. Six members of the Dow family of plastics are portrayed on these two pages in seven different product improvement roles. Reading time: One new idea per minute.

STREAMLINED TV SETS:

NEW EPOXY RESIN BREAKS THE BULK BARRIER

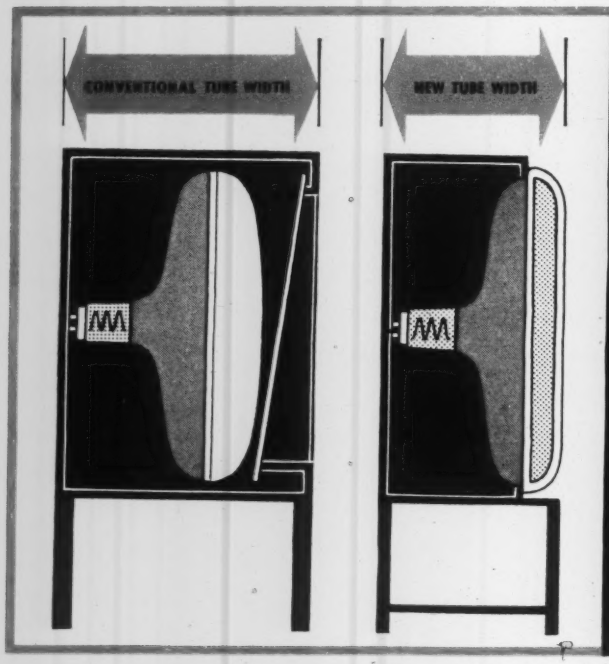
Brighter images, fewer reflections, larger picture areas also accrue from advance in TV tube design

When the TV set manufacturers set out to streamline TV cabinets, the first and foremost problem they faced concerned the "picture tube". Conventional set design calls for a glass safety panel mounted in front of an oval-faced tube. If a contoured safety panel could be laminated directly to the tube, a saving of several inches in the depth of the cabinet would be possible and the tube face could be flatter and almost square due to the extra strength of lamination.

Tube manufacturers brought the problem to the attention of Dow's Coatings Research Staff. The requirements: A material that would firmly bond glass to glass, stand up under the heat generated by the tube and not interfere with the transmission of the picture in any way. And, of course, the material had to lend itself to lamination on a production line basis.

Dow resin chemists developed a new epoxy resin that met these requirements with properties to spare! After months of testing, this new material is now in widespread use.

Eliminating the separate panel has some other important advantages besides streamlining. The area between the tube and the panel always served as a dust catcher, resulting in fogging of the picture. Also, the separate panel often caused double reflections, or glare, in the viewer's eyes. The new integrated, square-faced tube means greater picture area without increasing the basic size of the set.



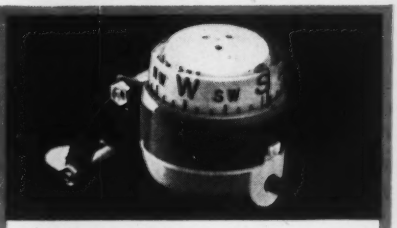
SALES POWER IN THE SHOWER

How would you like a shower fixture that softens, suds and scents the water? Just slip a soap pellet into this new type of shower head and you get a full three minutes of all three. A new product that has brought the sweet smell of sales success to its manufacturer, it's made of smooth, durable Styron® 683. Its crystal clarity harmonizes with any decor and lets you see if calcium deposits are building up inside. The excellent moldability of Styron 683 was put to good use in forming the minute spray holes.

HARDHEADED PERFORMANCE PAYS

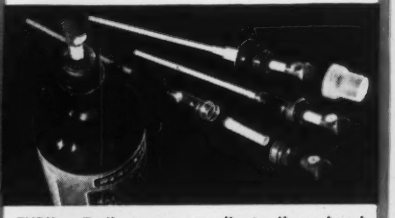
Sandlot grid stars wear this football helmet made of super tough Ethocel®. This lightweight, high gloss material is called the aristocrat of the thermoplastics because it has the best resistance to impact, especially at low temperatures. Thus this molded helmet offers a maximum of safety to young line chargers. Ethocel also resists weathering and is easy to clean. Like most Dow plastics, it is available in a wide range of colors. Its exceptional molding characteristics make large one-piece moldings practical and economical.

STYRON 480—Here's a trailer drainage system that will never corrodel Tough, durable Styron 480 can take the vibrations and bumps of normal trailer operation, has excellent chemical resistance.



TYRIL®—The housing of this car compass must be rugged, nonmagnetic and have good resistance to chemicals and distortion over a wide temperature range. These requirements make Tyril first choice.

PELASPAN®—New expand-in-place beads provide lightweight, durable insulation for this new cooler for sportsmen and picnickers. Pelaspan contributes maximum design flexibility, minimum production costs.



TYRIL—Tyril teams excellent dimensional stability and chemical resistance in this insecticide bottle top sprayer. Its superior moldability helps hold close tolerances on close-fitting parts.

THESE ARE JUST A FEW

of the countless ways Dow thermoplastics are helping to make new and improved product sales history. For more information about properties and applications of any Dow plastic, write to us today. THE DOW CHEMICAL COMPANY, Midland, Mich., Plastics Sales Dept. 1513C10.

Industrial Molding Materials

Packaging Materials • Building Products

Paint and Coating Materials

THE DOW CHEMICAL COMPANY
Midland, Michigan

DOW

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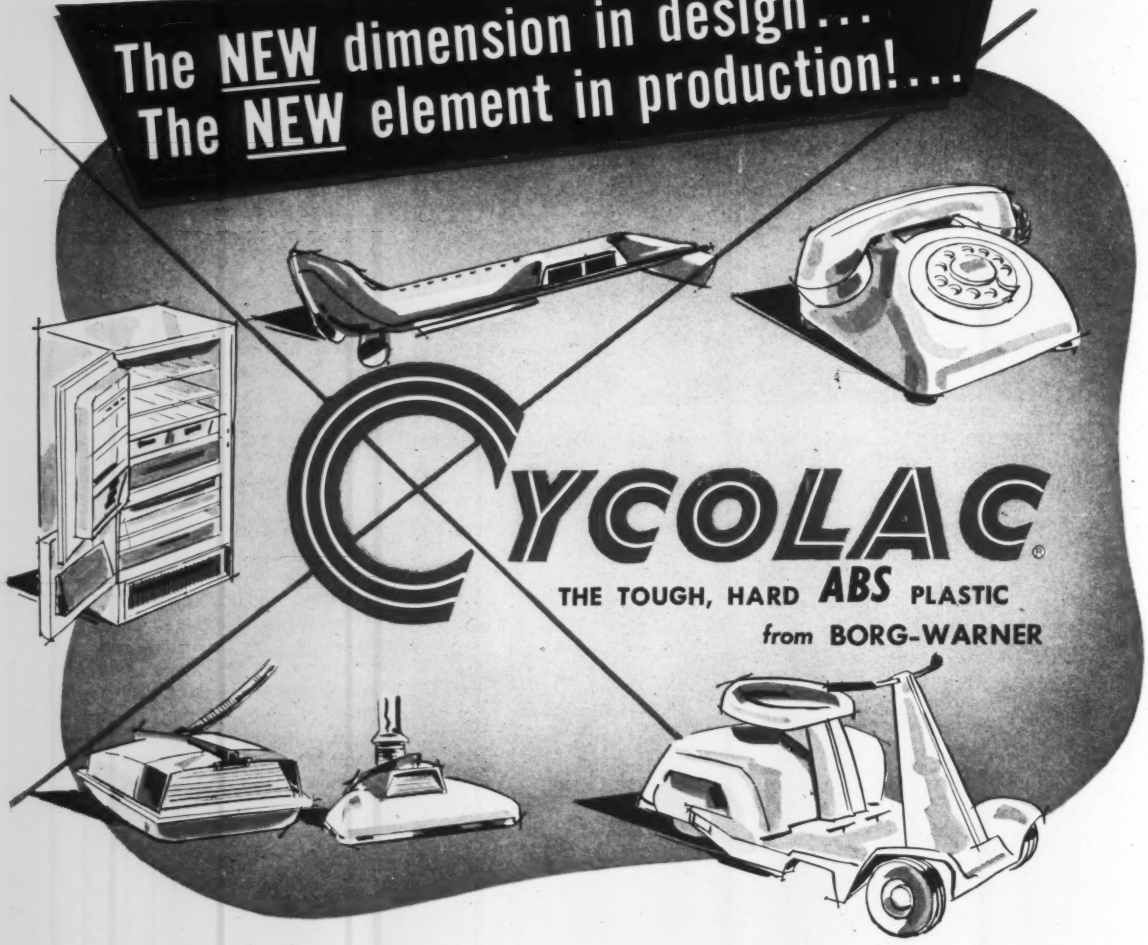
The NEW dimension in design...
The NEW element in production!...



Better in more ways than any other plastic!

Cycolac's unique combination of properties gives you unlimited freedom in product design coupled with new economy and speed in production! You get outstanding strength and rigidity without increasing wall thickness — you get corrosion, stain and temperature resistance — less overall weight — sparkling colors and hard, glossy surface. With Cycolac, you can simplify basic construction, take advantage of molded contours, forms and shapes unobtainable or too costly in other materials. And you get every advantage, every economy of high-speed injection molding or vacuum forming.

- **Superior Impact Strength — even at Low Temperatures**
- **Rigidity — even at High Temperatures**
- **Hard, Glossy Surface**
- **Corrosion, Stain Resistance**
- **Wide Range of Colors**
- **Good Electrical Properties**
- **Dimensional Stability**
- **Outstanding Performance**

WRITE FOR COMPLETE TECHNICAL INFORMATION!

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Marbon CHEMICAL
SYNTHETIC RESINS

Division of BORG-WARNER • Washington, W. Va.

also represented by:
WEST COAST: Harwick Standard Chemical Co., Los Angeles, Cal.
CANADA: Dillons Chemical Co. Ltd., Montreal & Toronto
EXPORT: British Anchor Chemical Corp., New York

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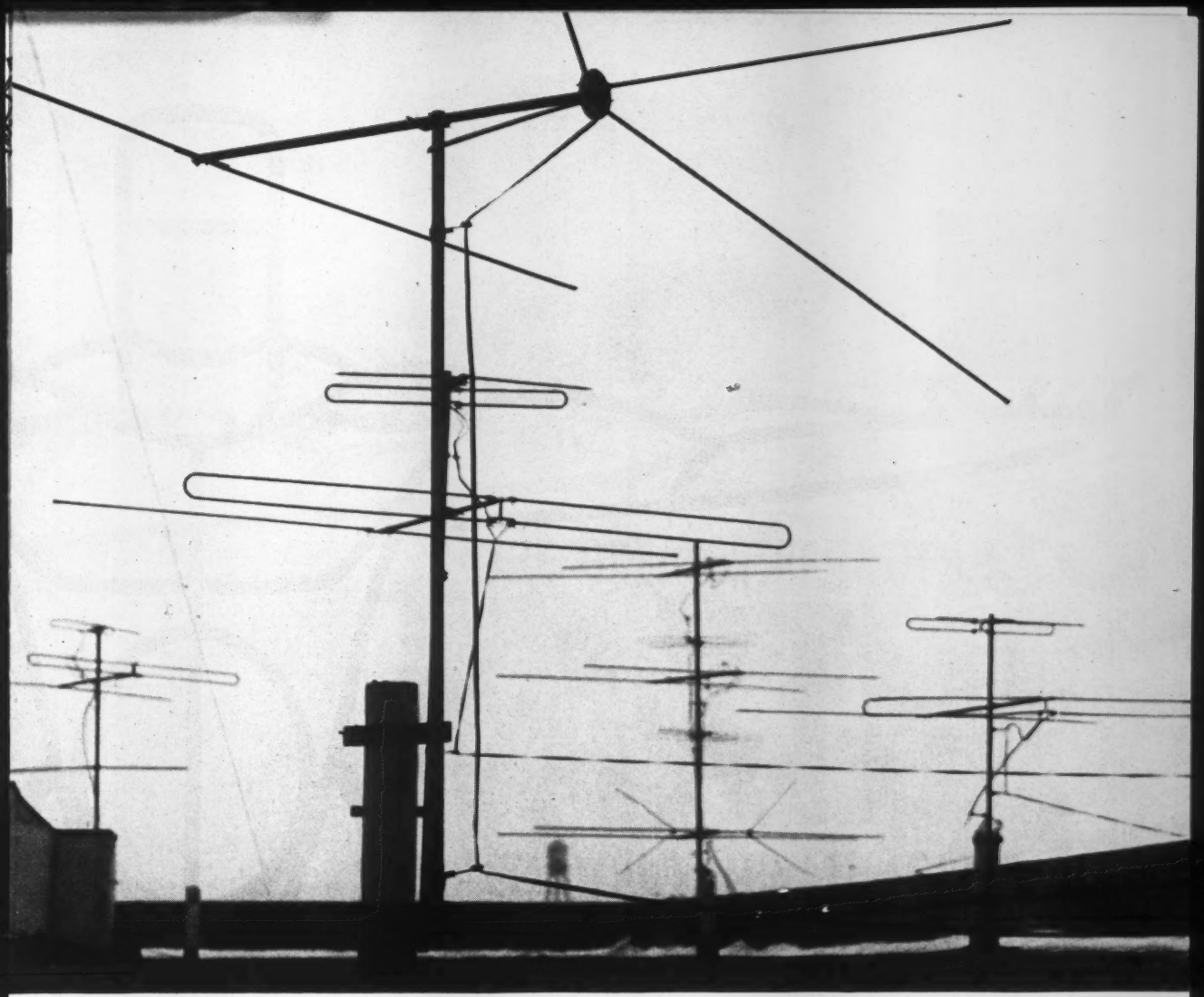


WHICH ONES WILL LAST (and last, and last!)?
THOSE MADE OF WEIRKOTE® ZINC-COATED STEEL!

Steel tubing that's protected against corrosion even under the most trying circumstances. Steel tubing that's easily fabricated to meet the most exacting specifications.

That's what you get in tubing made of Weirkote zinc-coated steel!

Weirkote's zinc coating—applied by the continuous process throughout, and so uniformly that every square inch is protected—is skin-tight. There's absolutely no flaking or peeling no matter how tortuous the crimping, twisting or other stresses of fabrication. In fact, Weirkote can be worked to the very limits of the steel itself.

The use of Weirkote can eliminate the need for any further coating process after fabrication. Its tight zinc coating is completely intact and remains so during fabrication and on the job. Weirkote zinc-coated steel tubing is particularly suited for jobs where weather is a factor to be taken into consideration.

Take a good long look at the possibilities and advantages of using Weirkote zinc-coated steel to meet your tubing requirements. For the complete story on Weirkote and how it can help you, write Weirton Steel Company, Dept. E-7, Weirton, West Virginia.

WEIRTON STEEL COMPANY

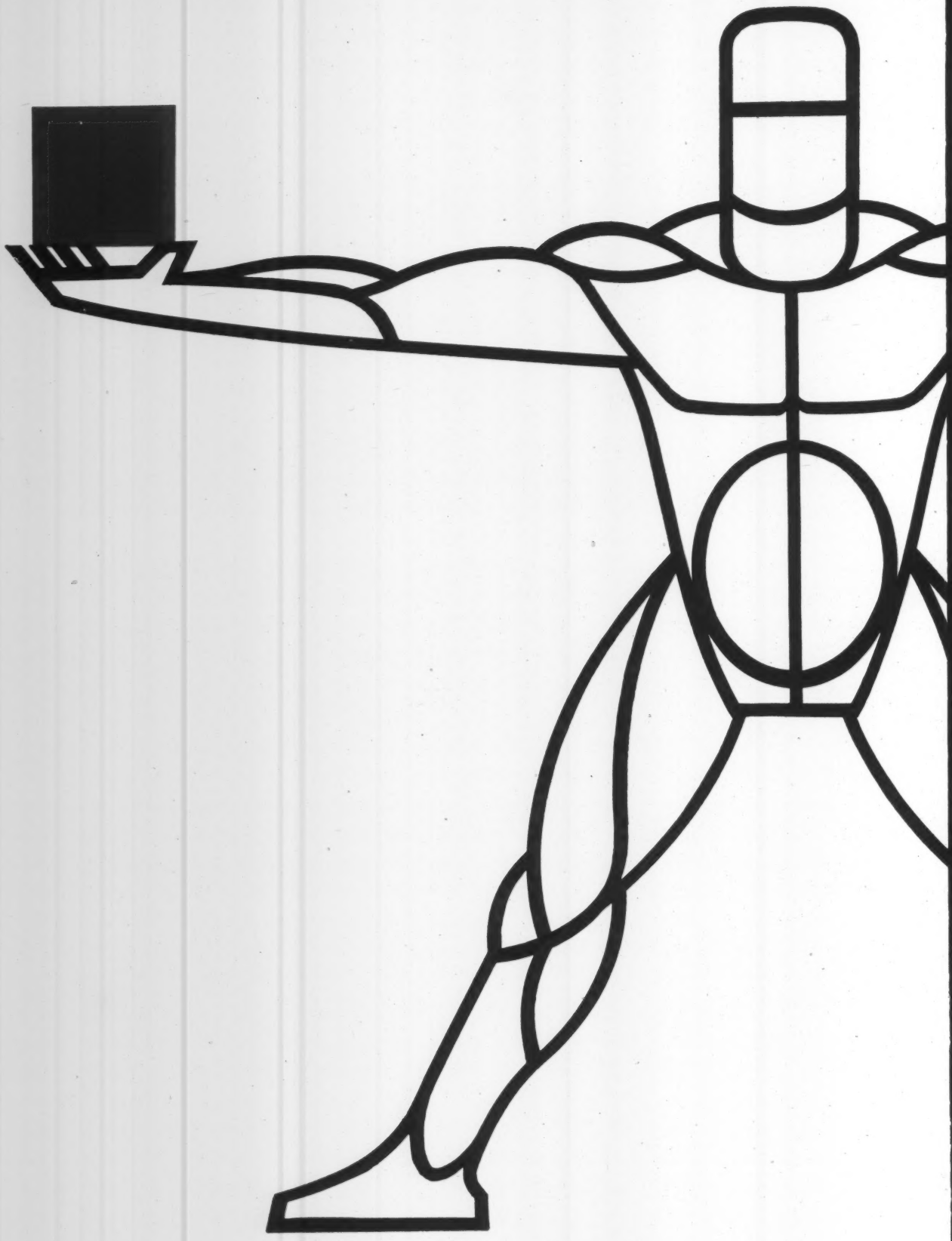
WEIRTON STEEL COMPANY

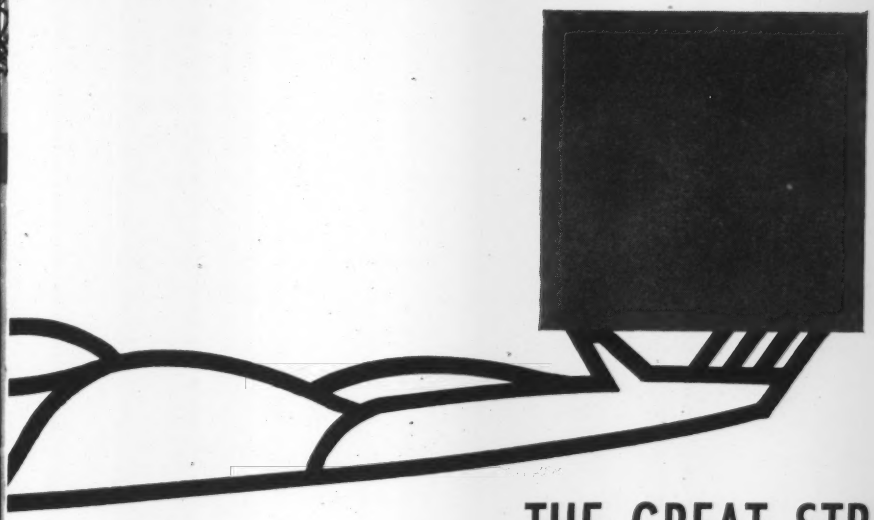
WEIRTON, WEST VIRGINIA

a division of

NATIONAL STEEL CORPORATION

For more information, turn to Reader Service card, circle No. 421





THE GREAT STRENGTH OF N-A-XTRA

LETS YOU ELIMINATE COSTLY DEAD WEIGHT FROM YOUR PRODUCTS

N-A-XTRA is the best low-alloy, extra high-strength steel you can buy. Heat-treated, fully quenched and tempered, it's now available in minimum yield strength levels of 80,000—110,000 psi. This is nearly three times the strength of ordinary carbon steel.

The great strength of N-A-XTRA gives engineers and designers a unique opportunity to eliminate bulky, useless dead weight from finished products. Production men will delight in its superior formability and superb weldability. Send today for our illustrated brochure on N-A-XTRA HIGH-STRENGTH steel. Great Lakes Steel Corporation, Detroit 29, Michigan, Dept. D-8.

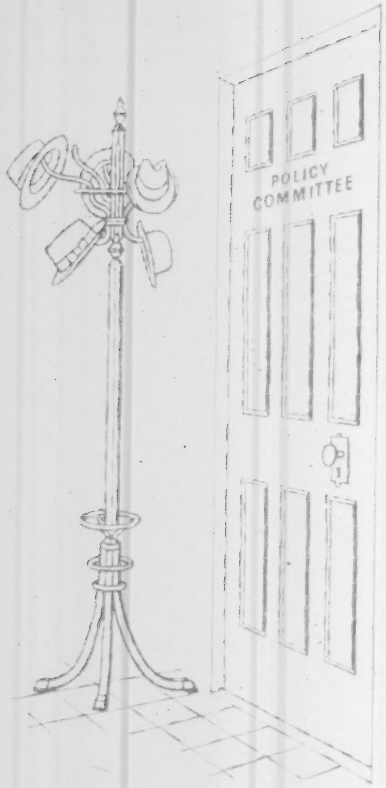
N-A-XTRA

GREAT LAKES STEEL

A DIVISION OF NATIONAL STEEL CORPORATION

For more information, turn to Reader Service card, circle No. 488

management must act



There is no doubt about it.

In recent years the responsibilities of American management have multiplied tenfold, and the areas in which decisions must be made are expanding with every passing day.

For example, just this morning our purchasing agent came to my office with a problem that, at first glance, seemed to be exclusively within his jurisdiction. Yet, as he talked and explained the situation, I could see where our policy committee was going to be forced into establishing procedure in an entirely new area. Briefly, here is the problem Jim Harkness laid in my lap. In the past several months, Jim said, various of our product managers have been requesting purchasing to buy foreign-made components to be used in the production operations carried out in their departments. These products, Jim went on, were somewhat cheaper than similar products made in the United States. Of course, the product managers were looking only at costs and were not considering such things as service and quality.

Also, Jim said, the purchasing of these imported products was presenting new problems to him as purchasing agent—problems that he sincerely felt should be answered by top management.

Problem number one, he said, showed up when one of our long-time suppliers said that if he continued to lose our business because of our purchase of a foreign-made competitive line, he had no other alternative than to shut down several machines and lay off their operators. This, Jim felt, could be the beginning of a vicious circle—the laid off men would curtail their buying and even though small at the present time, if the same thing happened to others of our suppliers, and in other segments of industry, the resulting ripples could turn into waves which would be felt throughout our entire economy. He also pointed out that, in his opinion, the purchase of imported goods had serious ramifications in other areas. The foreign manufacturer contributed absolutely nothing to the United States in return for his orders—he paid no property or corporate taxes, wasn't bothered by State levies and didn't have to pay personal income tax on his profits. As far as he could see, Jim said, the only result was that the rest of us would have to pay higher taxes all around in order to subsidize the foreign manufacturer.

Jim also declared that he felt imports damaged us in still another way. Not only do they represent the loss of domestic markets—high import figures also indicate the loss of export markets. As an example of this, he explained that U.S. brass mills formerly did a large export business. Today they have lost the export business and suffer seriously from imports. The total loss in this industry is, therefore, the loss of exports plus imports.

It was these conclusions, Jim said, that had brought him to my office. When his actions as purchasing agent began to have such far reaching consequences he felt that management should assume some of the added responsibility.

Since Jim left, I've been thinking of the things he said—and I think he's right. I'm going to recommend that our policy committee establish a buying procedure stating that we as a company will place our requirements for our United States operations with American sources in all cases where U.S. products are available. I cannot see how we can afford to do otherwise.

BOOTH 519
11th EXPOSITION
AIR-CONDITIONING AND REFRIGERATION INDUSTRY
ATLANTIC CITY, N. J.
NOV. 2-3-4-5 1959

CALUMET & HECLA, INC.
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DIVISION OF
CALUMET & HECLA, INC.
17258 Southfield Road
Allen Park, Michigan
Manufacturers of Quality-Controlled Tubing and Extruded Aluminum Shapes

MADE IN U.S.A. TO THE STANDARDS OF AMERICAN INDUSTRY

PLANTS IN DETROIT, MICHIGAN, AND DECATUR ALABAMA. SALES OFFICES IN PRINCIPAL CITIES.

For more information, turn to Reader Service card, circle No. 451

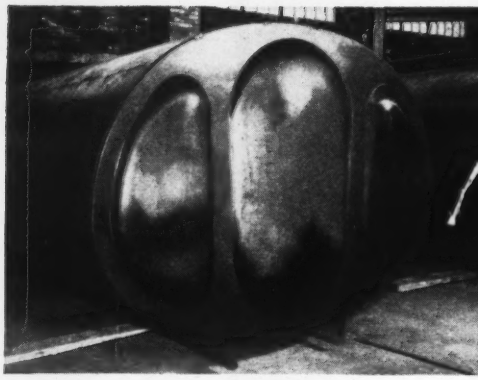
STRENGTH AND UNIFORMITY are outstanding characteristics of the automotive ball-joint bearings shown below. These sintered metal parts demonstrate Moraine Products' capabilities in working with customers to develop the most practical designs. They also demonstrate Moraine Products' responsibilities—making economically, and in quantity, parts that must not fail under the most rugged operating conditions.

Parts shown ½ actual size.

Vital parts for industrial progress

Moraine Products
Division of General Motors, Dayton, Ohio

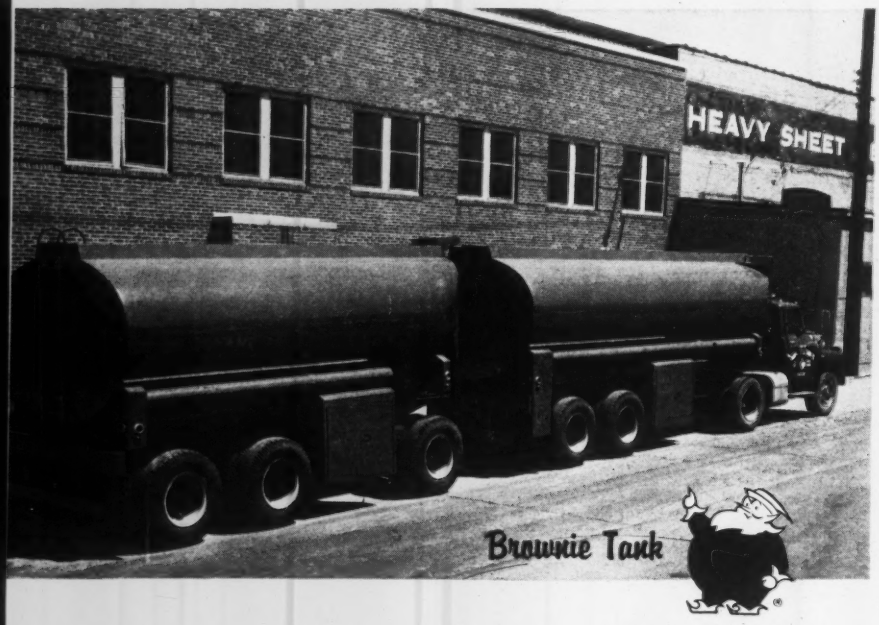
For more information, turn to Reader Service card, circle No. 506



Brownie Stress Distributing Head
fabricated from Youngstown Yoloy "E" High-Strength Steel distributes liquid surge shocks and vertical load within trailer tanks.

Accent on Excellence

Youngstown Yoloy "E" high-strength steel



This new, rugged Brownie trailer tank train can haul 11,500 gallons of petroleum products in a single trip! Its tank shells and internal stress distributing heads are fabricated exclusively from Youngstown Yoloy "E" Steel. This high-strength, low-alloy steel provides a stronger, lighter rig that carries larger payloads, requires little maintenance.

Brown Steel Tank Company of Minneapolis reports that Yoloy "E" withstands corrosion, resists shock and fatigue, and offers excellent weldability and formability . . . "naturals" for tank builder and user alike.

Wherever high-strength steel becomes a part of things *you* make, the high standards of Youngstown *quality*, the personal touch in Youngstown *service* will help you create products with an "accent on excellence". The Youngstown Sheet and Tube Company, Youngstown, Ohio. Carbon, Alloy and Yoloy Steel.

Youngstown

Send for free technical bulletin on Youngstown Yoloy "E" Steel.

For more information, turn to Reader Service card, circle No. 383

NAUGATUCK PARACRIL OZO

THE OIL-RESISTANT, OZONE-RESISTANT NITRILE RUBBER

Now—the finest weather-resistant wire jackets can be *Colored!*

FOR SALES APPEAL • FOR SERVICE EASE

New Paracril OZO—a superior rubber compound developed by Naugatuck—makes possible *new eye appeal, new ease of identification.* And it outperforms standard wire jacket compounds many other ways, too!

Compare new PARACRIL OZO with other wire jacket rubbers. Prove for yourself, new PARACRIL OZO gives:

- significantly superior ozone resistance
- greater fuel and oil resistance
- much greater abrasion resistance than standard jacket compounds
- excellent processability, with particularly fast extrusion
- *permanent retention of bright colors!*

If you are not already using PARACRIL® for your wire jacket compounds or similar products requiring such properties, chances are 1000 to 1 it's because you haven't yet *tried* PARACRIL OZO.

Why *not* try it—soon. Contact your nearest Naugatuck representative at the address below.

Naugatuck Chemical

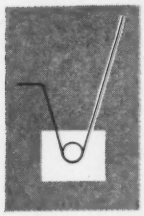
Division of United States Rubber Company

1040 Elm Street
Naugatuck, Connecticut

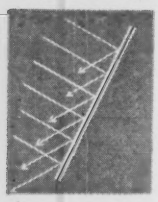
Rubber Chemicals · Synthetic Rubber · Plastics · Agricultural Chemicals · Reclaimed Rubber · Latices · CANADA: Naugatuck Chemicals Division, Dominion Rubber Co., Ltd., Elmira, Ontario · CABLE: Rubexport, N.Y.

For more information, turn to Reader Service card, circle No. 494

ARMCO
ALUMINIZED STEEL
TYPE 1

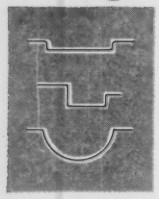


Sturdy steel coated with aluminum by a patented hot-dip process. No metal of comparable price can match ALUMINIZED STEEL Type 1 in resistance to destructive combinations of heat and corrosion.



The surface of this aluminum-coated steel reflects up to 80 per cent of radiant heat. It's used to "save" heat (hold it in) or to direct heat where it's wanted.

ALUMINIZED STEEL will withstand moderate forming, drawing or spinning operations without flaking or peeling



of the coating. Costs stay low because ALUMINIZED STEEL needs no further finishing after fabrication. Twenty years' experience by hundreds of manufacturers shows that products and parts made of ALUMINIZED STEEL mean service savings too—through longer life, more efficient operation.

For information about this aluminum-coated steel originated by Armco, write: Armco Steel Corporation, 2469 Curtis Street, Middletown, Ohio.

New steels are born at Armco

ARMCO STEEL

Armco Division • Sheffield Division • The National Supply Company • Armco Drainage & Metal Products, Inc. • The Armco International Corporation • Union Wire Rope Corporation

For more information, turn to Reader Service card, circle No. 458

RESULT: Better Finish at Lower Cost

In addition to the long recognized advantages of Eaton Permanent Mold Gray Iron Castings, the use of shell coring gives an even greater uniformity of structure and an improvement in internal surface finish. This results in machining economy and fewer rejections, which, in the end, mean lower cost of finished parts.

If you have applications where more than ordinary quality is required, Eaton Permanent Mold Gray Iron Castings offer many advantages. Whatever your requirements, our engineers will be happy to work with you.

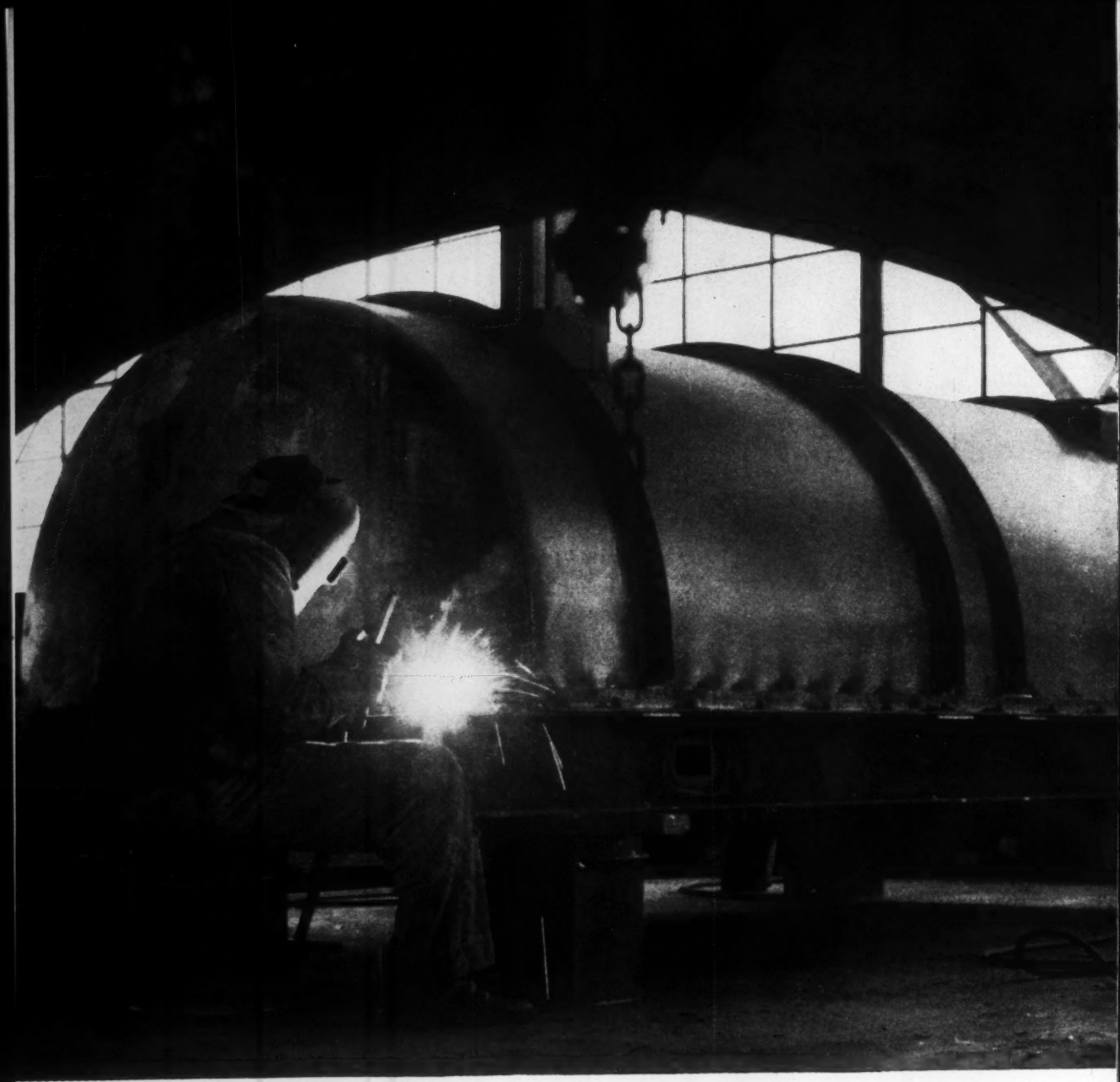
Send for Illustrated Descriptive Literature

Consider these Important Advantages

- ★ Intricately cored sections
- ★ Uniformity of castings
- ★ Higher machining feeds and speeds
- ★ Substantially increased tool life
- ★ Dense, non-porous, homogeneous structure
- ★ Freedom from inclusions
- ★ Excellent tensile strength
- ★ Ability to take high surface finishes
- ★ Freedom from leakage under pressure

EATON MANUFACTURING COMPANY
FOUNDRY DIVISION
VASSAR, MICHIGAN

For more information, turn to Reader Service card, circle No. 453



How to contain a jet engine

THE BALTIMORE STEEL COMPANY makes shipping containers for aircraft engines, torpedoes, missiles, and other ordnance items. The containers are designed to accompany their cargo almost into the enemy's teeth. They are impact-resistant, shock-mounted, hermetically sealed, pressurized and humidity-controlled.

There were three reasons why the designers selected USS COR-TEN High-Strength Low-Alloy Steel for the outer shells of these containers:

1. The contents demand that the containers be strong and impact-resistant . . . tactics demand that they be light and maneuverable. USS COR-TEN Steel has a minimum yield point of 50,000 psi—50% higher than carbon steel—so it can be used in stronger, thinner, lighter gages, saving as much as 100 lbs. per container.
2. To permit storage in the field, the containers must be highly corrosion-resistant, and USS COR-TEN Steel has four to six times more atmospheric corrosion resistance than carbon steel. The containers are reusable—have a service life of about ten years.
3. COR-TEN Steel saves money. First, its strength permits the use of *less* steel, cutting production costs an estimated 8%. Second, maintenance costs are reduced because paint life on COR-TEN Steel is 50 to 100% longer.

U. S. Steel produces three brands of High Strength Steels—COR-TEN, TRI-TEN, and MAN-TEN, in addition to the remarkable USS "T-1" Constructional Alloy Steel, and a complete line of stainless steels. Each has characteristics that make it ideal for special design applications. For complete information about these "steels that do more," write to United States Steel, 525 William Penn Place, Pittsburgh 30, Pa.

USS, COR-TEN, TRI-TEN, MAN-TEN and "T-1" are registered trademarks

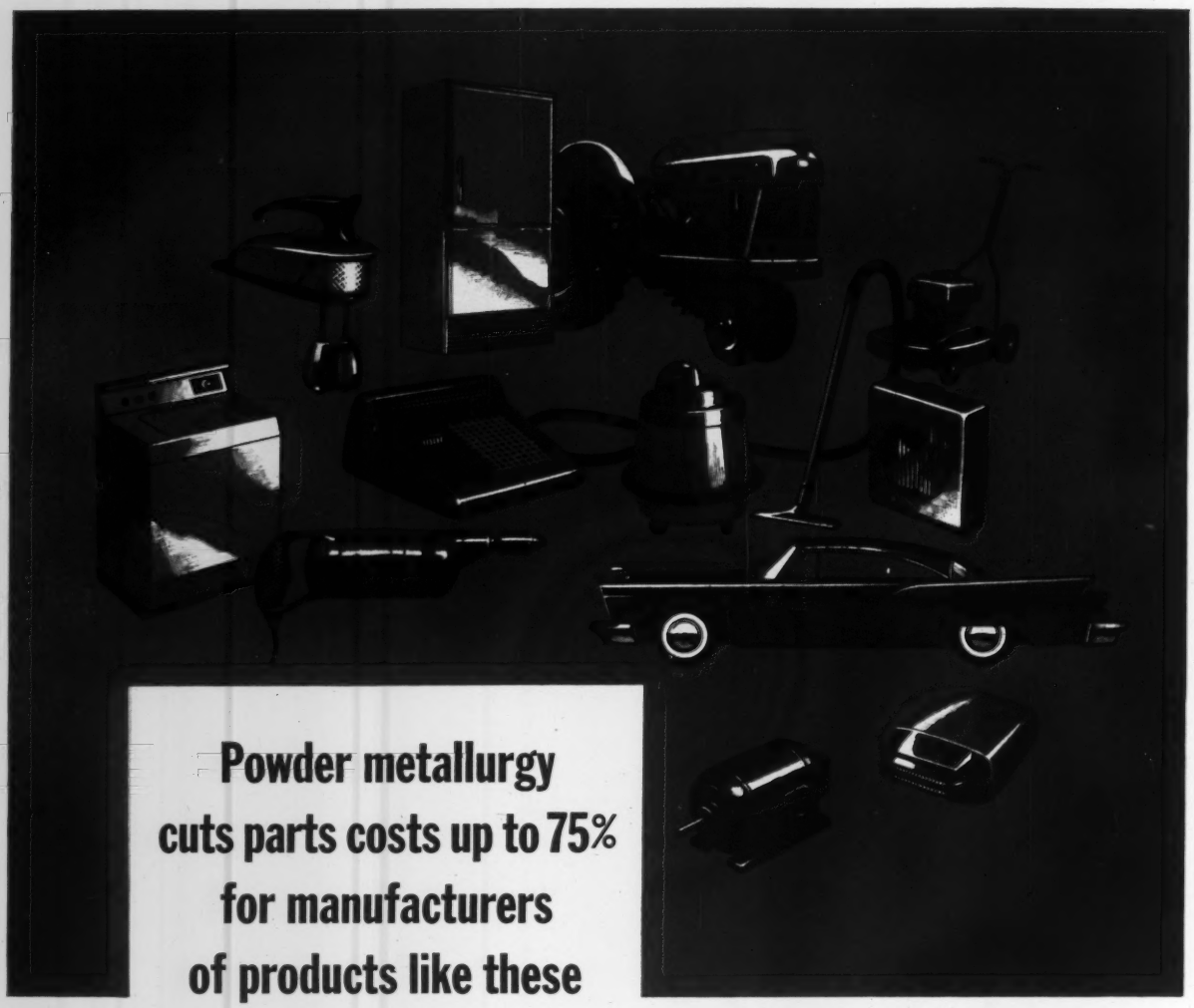
USS

United States Steel Corporation—Pittsburgh
American Steel & Wire—Cleveland
Columbia-Geneva Steel—San Francisco
Tennessee Coal & Iron—Fairfield, Alabama
United States Steel Supply—Steel Service Centers
United States Steel Export Company

United States Steel

Please direct inquiries to advertiser, mentioning MACHINE DESIGN

MR. C. EDWARD BELLEW, CHIEF ENGINEER, THE BALTIMORE STEEL COMPANY

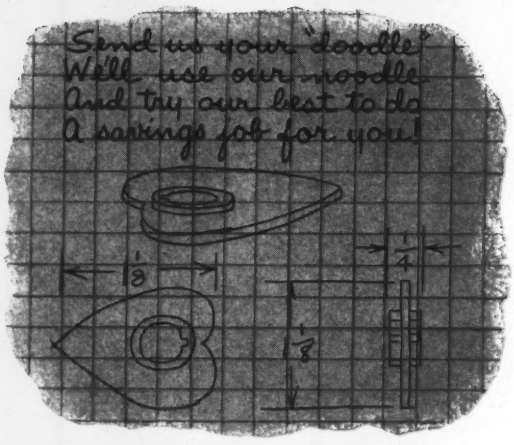


Powder metallurgy cuts parts costs up to 75% for manufacturers of products like these

Why not find out now if powder metallurgy holds the answer to your high parts costs?

Send Glidden a sketch of any part, plus the quantity desired. Glidden, with the help of qualified parts fabricators in your area, will determine, first, whether the part can be made with metal powder. If it can, you will receive cost quotations that may show really worthwhile savings—similar to savings realized by an increasing number of manufacturers who have found that metal powder parts can be mass-produced faster, better, more economically.

As a leading supplier of metal powders, Glidden works closely with parts producers. In this way, several staffs of experienced technicians may be at your disposal—to provide complete technical service and suggest possible design changes that may bring even lower parts costs.



QUALITY Glidden PRODUCTS

RESISTOX METAL POWDERS

The Glidden Company
Chemicals—Pigments—Metals Division
Hammond, Indiana

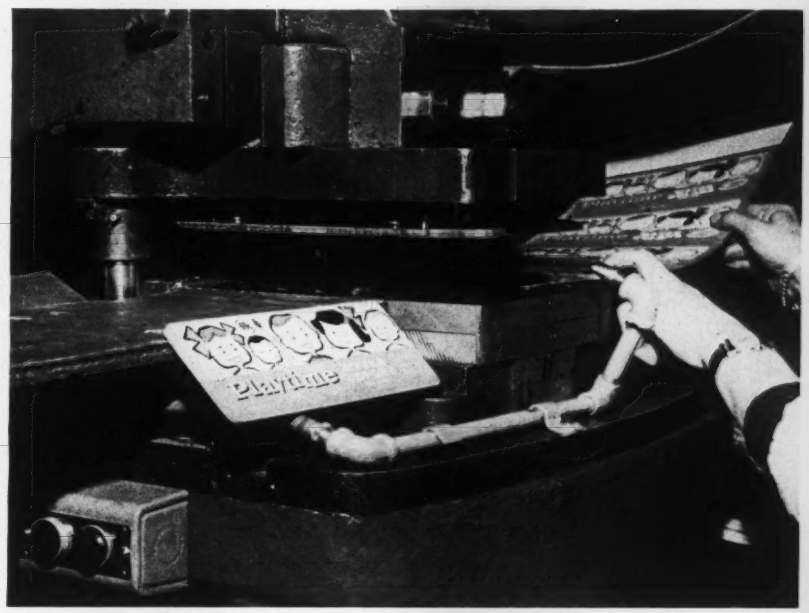
COPPER POWDER • LEAD POWDER • TIN POWDER • BRASS POWDER • ALLOY POWDER • FILTER POWDER
CUPRIC OXIDE • CUPROUS SULFIDE • CUBOND COPPER BRAZING PASTE • COPPER PIGMENT

For more information, turn to Reader Service card, circle No. 527

Tool Steel Topics

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

Export Distributor: Bethlehem Steel Export Corporation



Lehigh H Teams Up with Brake Die

Result: 150,000 Box Tops

The job was a tricky one. It called for the blanking and forming of .010-in. black plate into hinged tops for children's paint boxes. But with the black plate already lithographed, it was imperative to avoid marring the material.

The manufacturer, Sobel Metal Products Co., Easton, Pa., talked it over with his local Bethlehem tool steel distributor, Luria Steel Supply Co., Catasauqua, Pa. The Luria representative proposed the use of Lehigh H for the die, and Brake Die for the punch. This proved a wise choice, for combined, the two tool steel grades turned out 150,000 pieces without any need for redressing. And the black plate received nary a scratch.

Bethlehem Lehigh H (AISI D-2) is our easy machining high-carbon, high-chrome tool steel. It is an air-hardening grade, with plenty of wear-resistance thanks to its excellent carbide distribution. Brake Die, a grade of special analysis steel, is oil quenched and tempered to develop the mechanical properties needed for maximum wear and toughness.

Bethlehem regularly produces about 30 different grades of tool steel—a range so wide as to meet virtually every requirement. For full information, call your Bethlehem tool steel distributor.

BETHLEHEM TOOL STEEL ENGINEER SAYS:

Hot-Work Tools Last Longer When Thermal Stress Is Reduced

Deterioration of hot-work tools in service by heat checking or cracking depends largely on the severity of thermal stress developed in service. Anything which can be done to decrease the magnitude of the thermal stress will increase the service life of the tools.

One of the most essential steps in using hot-work tools is to preheat them to their normal working temperature before use. This seemingly insignificant step will often improve the tool life appreciably because it decreases the severity of the initial stress cycles.

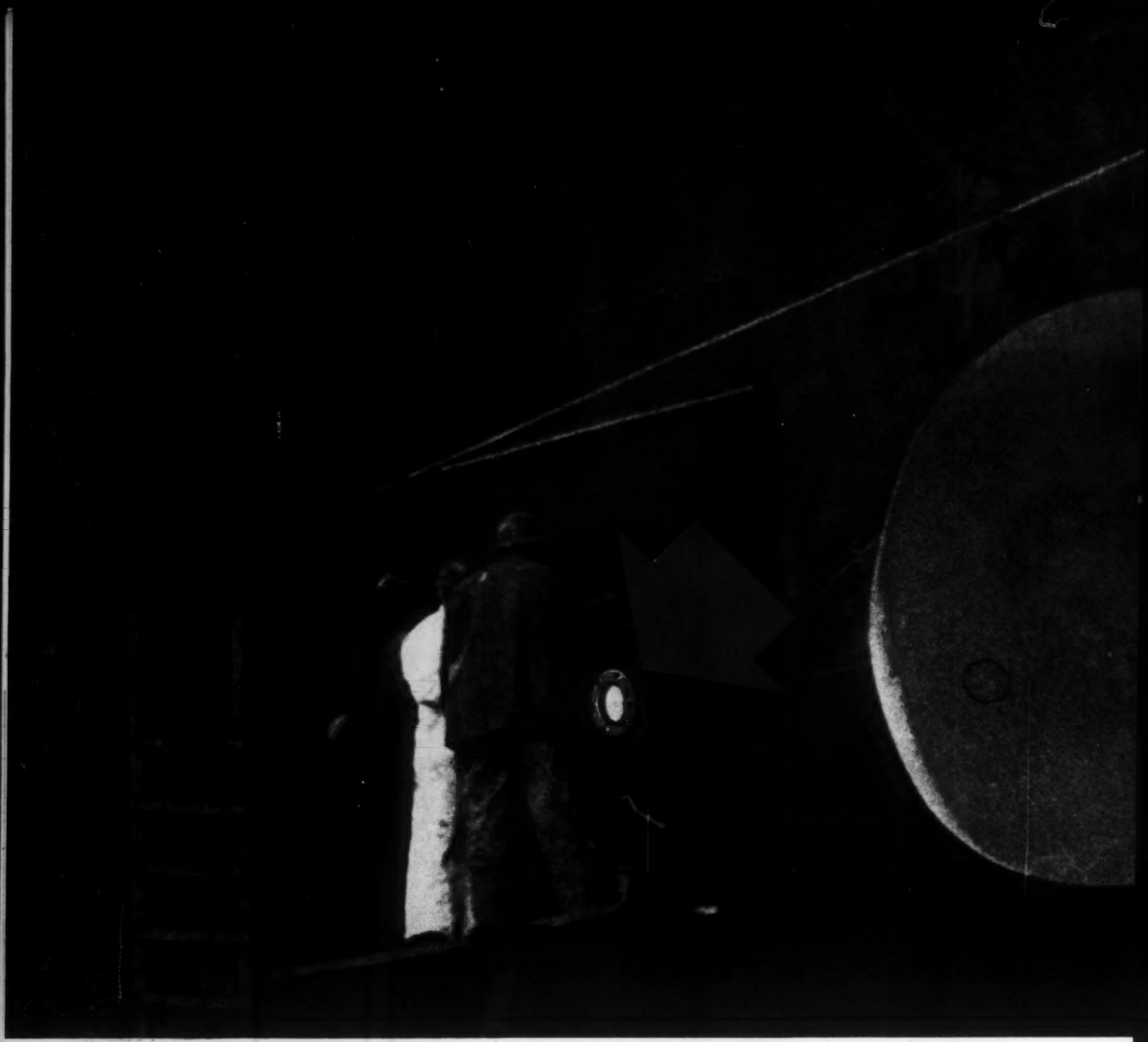
The provision of multiple tools which are used in succession is another simple way to decrease thermal stresses on certain types of hot-work tools. For example, on piercing operations the press may be provided with as many as six piercing punches mounted on an indexing fixture. After each piercing operation a different punch is moved into position for the next operation. This permits each punch to cool during the time of the next five operations, greatly reducing the severity of thermal stress. The service life of punches used in this manner is often twice that of punches used continuously in the same operation.

Air-4 hardens in air at 1550F.

With AIR-4 You Get Air-Hardening at Low Temperatures . . . FREE MACHINING . . . EXCELLENT WEAR

Air-4, Bethlehem's new medium-alloy tool steel, hardens in air at 1550F, and has excellent free-machining properties due to its carefully controlled addition of lead. It has exceptional wear-resistance and high toughness. Moreover, it can be heat-treated with complete freedom from the dangers of cracking. Ask your Bethlehem tool steel distributor for complete information on Air-4.

For more information, turn to Reader Service card, circle No. 497



PROTECTION OF SHIP'S HULL AND PROPELLER AGAINST CORROSION . . .

Where any metal but Platinum

PLATINUM DOES IT FOR LESS. Experience proves that platinum anodes used in the impressed current system of the type shown provide sure protection of ship hulls and propellers against corrosion . . . and do so economically. Equipment (called CAPAC* and designed by Engelhard Industries, Inc., Instrument Division) is being used on commercial vessels and pleasure craft as well as on atomic submarines and other Navy ships.

Who would think that the platinum metals provide a practical way to protect steel against attack by sea water?

But that's how underwater corrosion is being defeated today. In an automatic system, CAPAC*, devised by Engelhard Industries, Inc., Instruments and Systems Division, comparatively small anodes feed a corrosion-stopping protective electrical current to the hull and propeller.

Long life . . . obtainable only with platinum surfaced anodes . . . brings the real cost of this underwater protection system so low that it has become standard equipment on week-end sailors' steel-hulled pleasure boats.

A platinum metal may economically solve your problem

Where underwater hull protection is a problem . . . where a combination of severe corrosion and erosion must be met, as in the case of spinnerettes for rayon production . . . where wear-resisting, non-tarnishing surfaces are required, such as for printed electrical circuits . . . where product purity must be retained despite high temperatures, as in the case of lens glasses . . . or

would cost too much...

where peak catalytic efficiency is required, as in the refining of high octane gasoline . . . the platinum metals have proved to be the most economical for certain critical equipment.

Industry is going to higher temperatures and higher pressures. Perhaps your own progress has been blocked by the limitations of materials to withstand such severe conditions. The platinum metals have removed many barriers. Have you considered them for your problem?

Platinum, palladium, rhodium, ruthenium and iridium have unique potentials, well worth your attention. Specialists are prepared to work closely with you in evaluating these metals for new commercial and scientific uses.

As a first step, write us for additional data on the outstanding characteristics and successful applications of the six platinum metals and their alloys—indicating your field of interest or how we might be of assistance.

*Registered trademark of Engelhard Industries, Inc.

CAN THESE PROPERTIES OF THE PLATINUM METALS HELP YOU?

Exceptional Chemical Inertness
Superior Wear Resistance
High Temperature Stability
Peak Catalytic Activity
Low Vapor Pressure

The six platinum metals are:

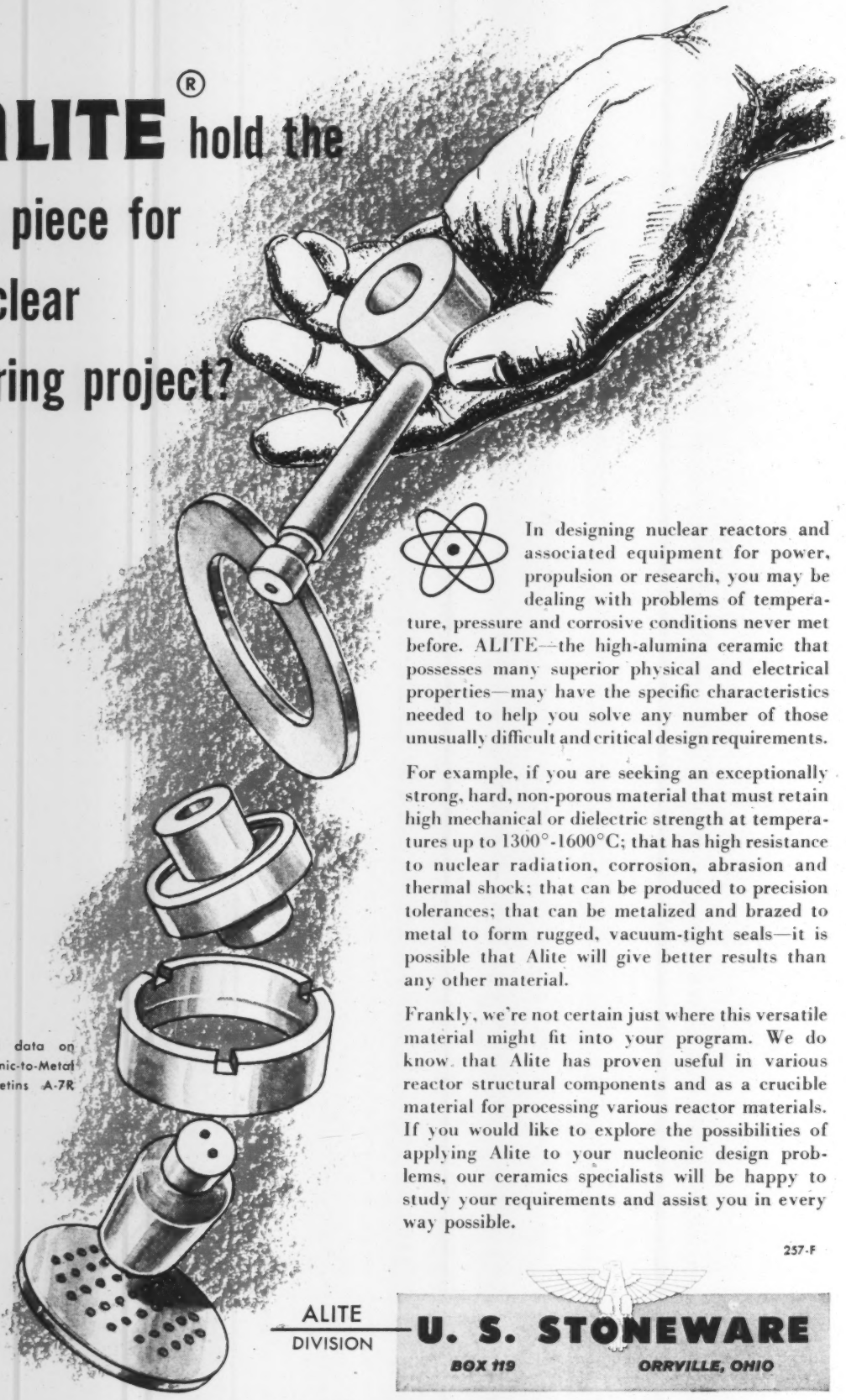
PLATINUM • PALLADIUM • RHODIUM
RUTHENIUM • IRIDIUM • OSMIUM

INCO TRADE MARK

PLATINUM METALS DIVISION, The International Nickel Company, Inc., 67 Wall Street, New York 5, N.Y.

For more information, turn to Reader Service card, circle No. 505

Does ALITE® hold the missing piece for your nuclear engineering project?



In designing nuclear reactors and associated equipment for power, propulsion or research, you may be dealing with problems of temperature, pressure and corrosive conditions never met before. ALITE—the high-alumina ceramic that possesses many superior physical and electrical properties—may have the specific characteristics needed to help you solve any number of those unusually difficult and critical design requirements.

For example, if you are seeking an exceptionally strong, hard, non-porous material that must retain high mechanical or dielectric strength at temperatures up to 1300°-1600°C; that has high resistance to nuclear radiation, corrosion, abrasion and thermal shock; that can be produced to precision tolerances; that can be metalized and brazed to metal to form rugged, vacuum-tight seals—it is possible that Alite will give better results than any other material.

Frankly, we're not certain just where this versatile material might fit into your program. We do know that Alite has proven useful in various reactor structural components and as a crucible material for processing various reactor materials. If you would like to explore the possibilities of applying Alite to your nucleonic design problems, our ceramics specialists will be happy to study your requirements and assist you in every way possible.

257-F

For detailed technical data on Alite and Alite Ceramic-to-Metal Seals, write for Bulletins A-7R and A-20R.

ALITE DIVISION

U. S. STONEWARE

BOX 119 ORRVILLE, OHIO

For more information, turn to Reader Service card, circle No. 479

Why Gamble on Your Die-Castings?

You know they're "on-grade" when produced by DOLLIN under the

CERTIFIED ZINC ALLOY PLAN

Alloy purity and control rigidly maintained to meet strictest metallurgical specifications

How can you be sure your zinc die-castings conform to the strict chemical composition limits for maximum mechanical and physical properties?

The answer is simple . . . buy your zinc die-castings from DOLLIN—one of the licensed producers of die-castings under the Certified Zinc Alloy Plan. Be sure your supplier displays the C-Z seal—that's all you need to know.

What does C-Z mean to you? It means that your zinc die-castings will have the maximum in high mechanical strength, dimensional stability, good machineability and fine surface finish. No risk of casting deterioration in service due to variations in alloy composition.

Do C-Z die-castings cost you more? No — because DOLLIN (like other members of the C-Z Plan) is a leader in the field, with the experience, equipment, engineers and techniques to improve designs, suggest economies and efficiently produce your die-castings at lowest cost. Price buying, without C-Z protection, can be a costly gamble.

CERTIFIED ZINC ALLOY PLAN — LICENSED PRODUCER — AMERICAN DIE CASTING INSTITUTE

How the Z seal protects buyers of zinc die-castings

Die-casters licensed under the C-Z plan regularly must submit sample castings to independent laboratories for analysis. In addition, field representatives periodically visit each plant *without notice* to select samples from each die-casting machine, for testing. Every sample must test "on-grade" to retain the valuable C-Z license.

DOLLIN CORPORATION · 25th ANNIVERSARY 1934-1959 · Die-Castings

Dollin invites you to submit prints or samples of parts for engineering advice and quotation, without obligation. Write for 16-page brochure showing Dollin's facilities and services.

ASTM · DIE CASTING RESEARCH FOUNDATION PARTICIPANT · Z

Dollin Corporation, 610 So. 21st St., Irvington 11, N. J.

Sales Offices: Boston • Buffalo • Canton • Chicago • Detroit
Greensboro • Louisville • Memphis • Philadelphia • St. Paul

See "Yellow Pages" for nearest office.

DOLLIN Zinc & Aluminum DIE-CASTINGS

For more information, turn to Reader Service card, circle No. 438

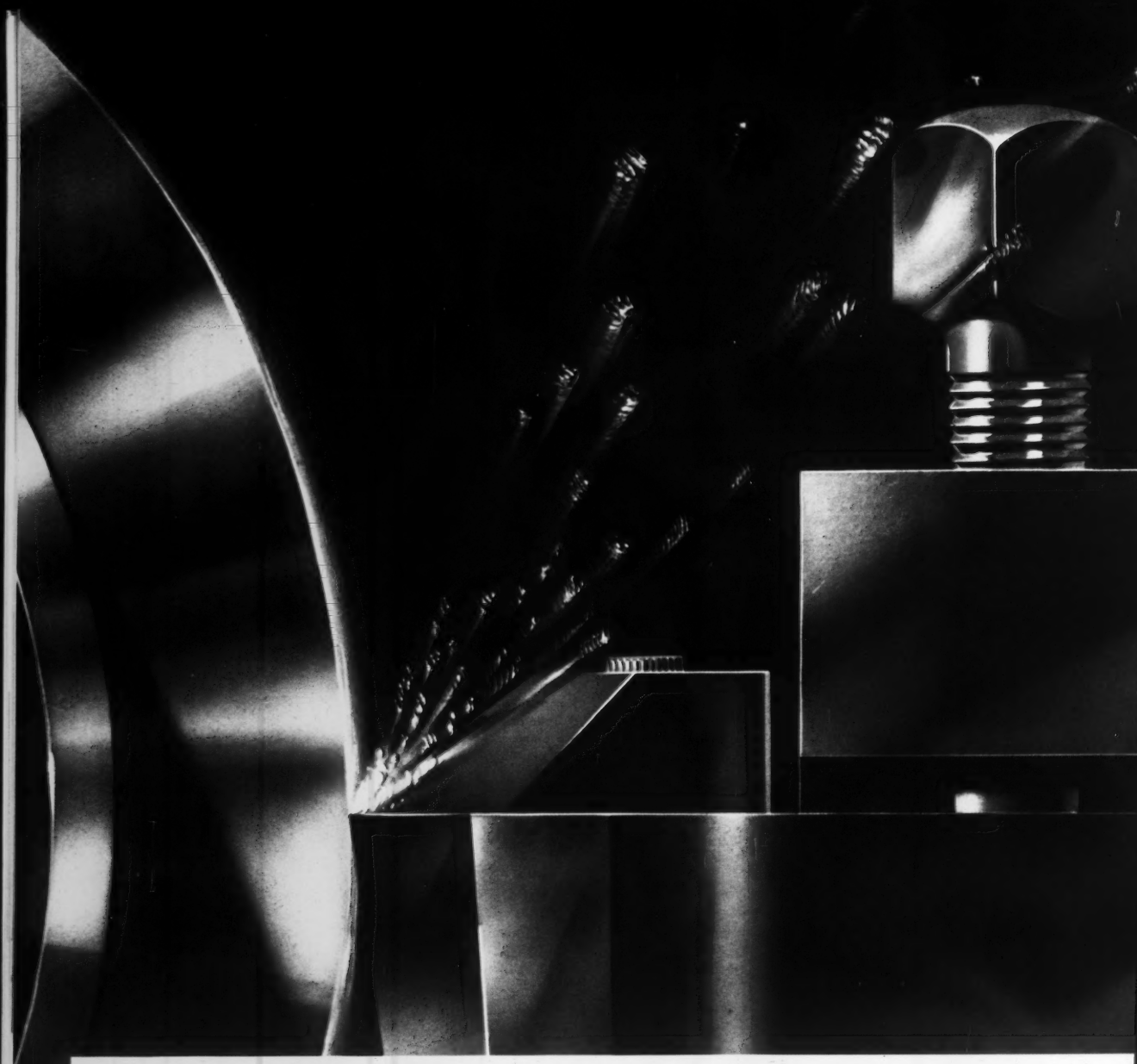


Illustration of Malleable casting being turned at 1,400 surface feet per minute with a 0.100" depth of cut using an oxide tool.

Machinability is Malleable

It's the finished cost of machined components that's important to you. Remember then . . . Malleable iron is more machinable than any other ferrous metal of similar properties. With Malleable castings you'll reduce machining time as much as 50% . . . increase tool life up to 250% . . . get unexcelled surface finishes . . . and end your reject problems.

To find out how much you can cut your costs and improve your profits, contact one of the progressive firms that displays this symbol—

MEMBER
MALLEABLE
CASTINGS COUNCIL

If you wish, you may inquire direct to the Malleable Castings Council, Union Commerce Building, Cleveland 14, Ohio, for information.

(Advertisement)

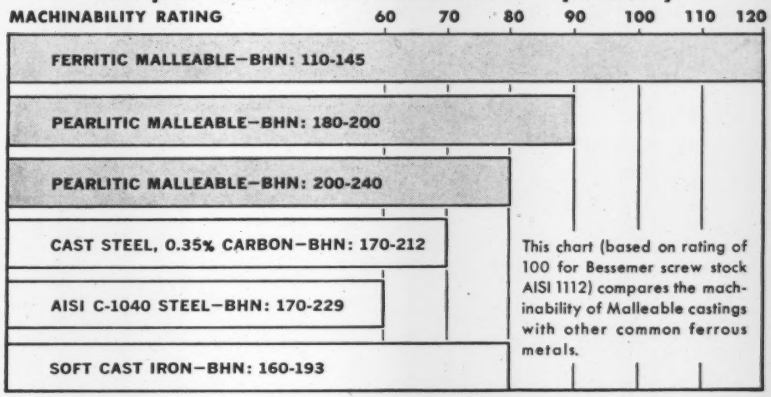
Machining Malleable Castings—Important Key to Cost Reduction

Malleable castings—the most machinable of all ferrous metals—cut quality components costs

Production men know that machining time, power consumption and rejects drop with the use of Malleable iron castings, while tool life and profits shoot up. The reason is simple: Malleable iron is the most machinable of all ferrous metals of similar properties.

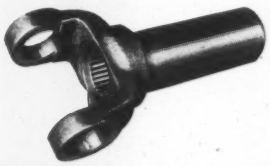
The following important factors work together to give Malleable such machining superiority: Malleable's microstructure contains tiny, evenly distributed nodules of carbon that help cutting tools quickly break the removed metal into small (Class A) chips; the carbon also acts as a lubricant, prolonging tool life; uniformity of properties throughout every casting permits running at optimum machining conditions.

Comparison Shows Malleable's Superiority



Typical Example Shows Savings of 70% to 250%

The conversion of automotive universal joint yokes from steel forgings to pearlitic Malleable castings typifies the savings provided by Malleable castings. Costs for the rough pieces and performance characteristics of the two materials are comparable. However, the castings are much more economical to machine. Considering that machining often costs two to four times as much as the rough parts, the economy resulting from using Malleable castings is substantial.



Conversion of this universal joint yoke to a Malleable casting increased production, lowered direct and tool room labor, and cut tool replacement.

One volume user of Malleable joint yokes reports the following savings after changing from steel to Malleable castings: 70% longer tool life in broaching the splines; 250% more pieces cut by the nut seat cutters; 149% more pieces in turning and facing the hub; an increase of 100% in production between wheel dressings in grinding the hub; 246% greater production in drilling the cross holes.

In each of these operations, the change to Malleable castings cuts direct production time by reducing the frequency of tool changes. Tool room labor and tool replacement are both reduced to fractions of their previous costs.

Throughout the metalworking industry, part after part is now being initially designed of Malleable or converted from other materials to take advantage of Malleable's unrivalled machinability . . . to produce better parts at lower costs.

New Information Now Available on Machining Malleable

Data Unit 106—Machinability of Malleable Castings—can be obtained from any member of the Malleable Castings Council, or from the Malleable Castings Council, Union Commerce Building, Cleveland 14, Ohio.

These companies are members of the

MALLEABLE CASTINGS COUNCIL

CONNECTICUT
Connecticut Mall. Castings Co., New Haven 6
Eastern Malleable Iron Co., Naugatuck
New Haven Malleable Iron Co., New Haven 4

DELAWARE
Eastern Malleable Iron Co., Wilmington 99

ILLINOIS
Central Fdry. Div., Gen. Motors, Danville
Chicago Malleable Castings Co., Chicago 43
Moline Malleable Iron Co., St. Charles
National Mall. and Steel Castings Co., Cicero 50
Peoria Malleable Castings Co., Peoria 1
Wagner Castings Company, Decatur

INDIANA
Link-Belt Company, Indianapolis 6
Muncie Malleable Foundry Co., Muncie
Terre Haute Mall. & Mfg. Corp., Terre Haute

MASSACHUSETTS
Belcher Malleable Iron Co., Easton

MICHIGAN
Albion Malleable Iron Co., Albion
Auto Specialties Mfg. Co., Saint Joseph
Cadillac Malleable Iron Co., Cadillac
Central Fdry. Div., Gen. Motors, Saginaw

MINNESOTA
Northern Malleable Iron Co., St. Paul 6

NEW HAMPSHIRE
Laconia Malleable Iron Co., Laconia

NEW JERSEY
Meeker Foundry Company, Newark 4

NEW YORK
Acme Steel & Mall. Iron Works, Buffalo 7
Frazer & Jones Company Division Eastern Malleable Iron Co., Solvay
Oriskany Malleable Iron Co., Inc., Oriskany
Westmoreland Mall. Iron Co., Westmoreland

OHIO
American Malleable Castings Co., Marion
Canton Malleable Iron Co., Canton 5
Central Fdry. Div., Gen. Motors, Defiance
Dayton Mall. Iron Co., Ironton Div., Ironton
Dayton Mall. Iron Co., Ohio Mall. Div., Columbus 16
Maumee Malleable Castings Co., Toledo 5
National Mall. and Steel Castings Co., Cleveland 6

PENNSYLVANIA
Buck Iron Company, Inc., Philadelphia 22
Erie Malleable Iron Co., Erie
Lancaster Malleable Castings Co., Lancaster
Lehigh Foundries Company, Easton
Meadville Malleable Iron Co., Meadville
Pennsylvania Malleable Iron Corp., Lancaster

TEXAS
Texas Foundries, Inc., Lufkin

WEST VIRGINIA
West Virginia Mall. Iron Co., Point Pleasant

WISCONSIN
Belle City Malleable Iron Co., Racine
Chain Belt Company, Milwaukee 1
Federal Malleable Company, West Allis 14
Kirsh Foundry Inc., Beaver Dam
Lakeside Malleable Castings Co., Racine
Milwaukee Malleable & Grey Iron Works, Milwaukee 46

For more information, turn to Reader Service card, circle No. 501

DOW | METAL PRODUCTS

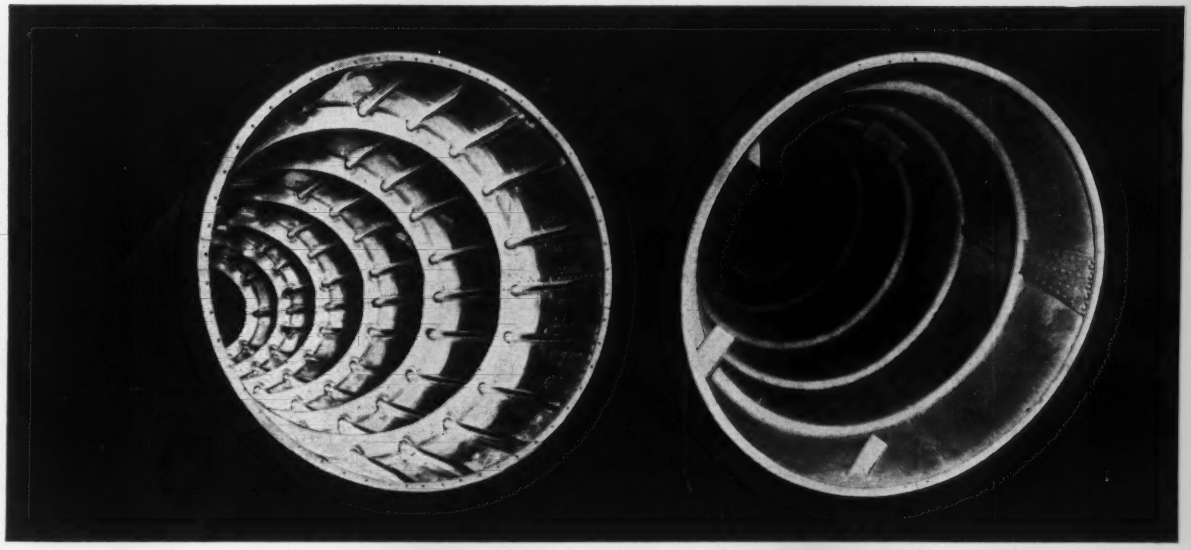
LIGHTWEIGHT DESIGNS

save more than weight

Designers reap a rich harvest of additional benefits as a result of lightness when they use magnesium. Bonuses such as more payload, simplified design, increased performance and reduced human exertion.

People who buy and use the luggage pictured above derive a very direct benefit from magnesium. As this lightweight luggage is made of magnesium, it saves human effort and fatigue. Also, the reduction of weight means more luggage can be carried without extra charge when traveling by air. Magnesium saves human exertion in other products, such as ladders, power tool housings and materials handling equipment.

Another example of the many savings and extra benefits that magnesium —and its resultant load lightening make possible for the designer is in the automotive field. One delivery truck unloads its last parcel and heads for the garage and the gas pump. Another, of identical size, goes on to deliver many



SIMPLIFIED DESIGN in magnesium aircraft part (right) was made possible by its advantageous stiffness-to-weight ratio.

more lbs. of merchandise. Why? The second truck is much lighter—its body is made entirely of magnesium alloy sheet, plate and extrusions. *Because* the second truck is lightweight, it can carry more payload. Or, it can carry the same payload as the first with less fuel, smaller tires and less wear and tear on the engine and transmission. Lighter trucks also save their owners money on license fees, insurance premiums and over-all maintenance.

An even more dramatic example is that of missile design. In one ballistic missile, the elimination of *one pound* of excess weight contributes approximately 18,000 feet of additional altitude and a comparable increase in range! This means vastly improved performance wherever magnesium can be substituted for heavier materials.

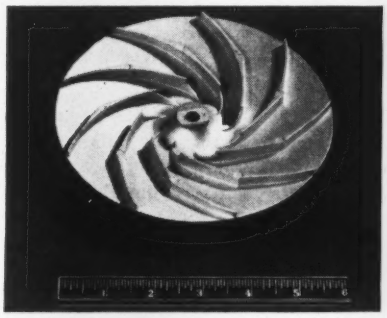
MAGNESIUM LIGHTNESS INCREASES STRENGTH, STIFFNESS

The designer who is seeking a stiff section can achieve it easily—and still save weight—with magnesium alloys. Magnesium weighs only 67% as much as aluminum, 25% as much as steel and zinc. A structure made of magnesium could be 8 times as stiff as the same part in steel if designed to equal weight. If equal stiffness is the design criterion, a magnesium section can weigh 62% less than steel and 25% less than aluminum.

Aircraft manufacturers have learned to exploit these facts to the fullest in conserving precious airborne weight. Critical parts such as wing and tail structures can be designed with more than adequate stiffness for high speed flying conditions. And, in addition to weight savings, magnesium helps provide a smooth aerodynamic surface and reduces "flutter" and "drag". Most important, the use of more rigid magnesium sections simplifies design by eliminating many of the stringers and stiffeners necessary with other materials.

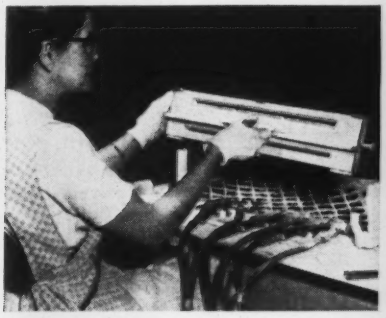
★ ★ ★

WRITE TODAY for new brochure, "Magnesium Design". For your copy of this valuable reference for designers, contact the nearest Dow sales office or write to THE DOW METAL PRODUCTS COMPANY, Midland, Michigan, Sales Department, 1342CD10.



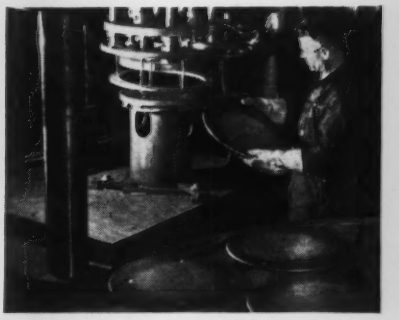
22,000 r.p.m. HOUSEHOLD ITEM

This die cast vacuum cleaner fan must rotate at 22,000 r.p.m. and have low starting inertia as well as high centrifugal strength. Only magnesium was able to meet the requirements of this specific design. Casting tolerances are held so closely there is no need for balancing.



WORKER FATIGUE THWARTED

A prominent automotive manufacturer uses magnesium paint shields in spraying speedometer panels. The weight saving compared to previous shields resulted in less fatigue, higher efficiency for women employees. The excellent alkali resistance of magnesium permits easy removal of dried paint.



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THE DOW METAL PRODUCTS COMPANY, Midland, Michigan

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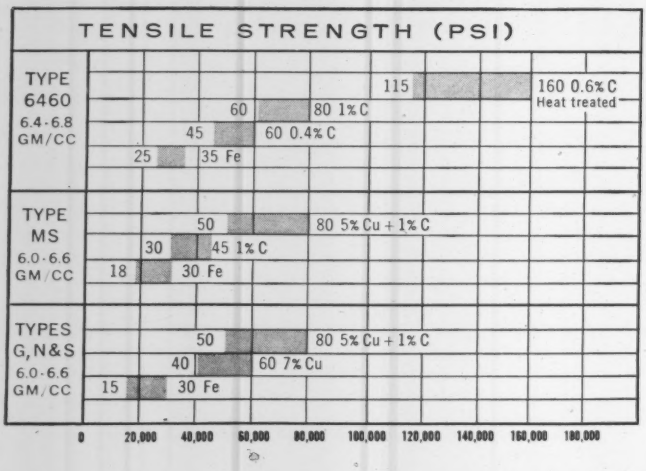

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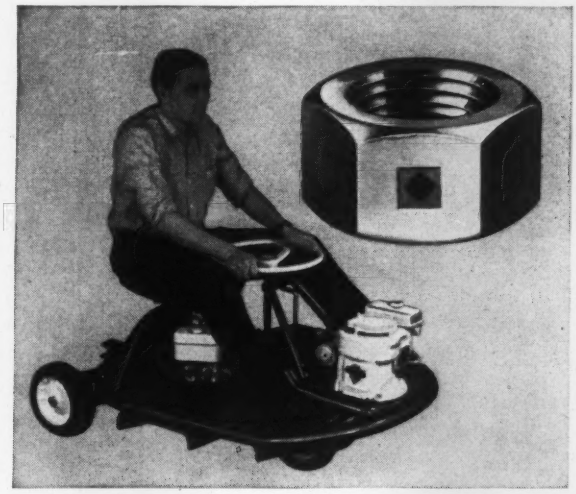

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Hardness, Shore D	43	48	60	78
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Tensile Strength at Break, psi	7000†	8825†	8500†	8500†
Elongation at Break, %	450	480	340	250
Split Tear, ASTM-D 470 lbs./linear inch	50	155	160	200
Compression/Deflection, psi @ 5% defl.	275	375	650	1400
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(High Hardness Compounds*)

*Softer compounds ranging from 10 Shore A are also available.

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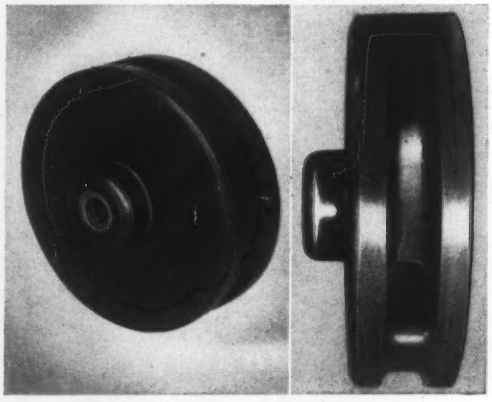

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In its raw state, ADIPRENE L is liquid in form. Cured polymers can be made in varying hardnesses—from 10 to 99 Shore A (78 Shore D). These vulcanizates are outstanding in abrasion resistance, low temperature performance, and oil resistance. They resist the attack of oxygen, ozone, radiation, many chemicals and solvents.

You will want to evaluate this new synthetic rubber in improving the products you design. The performance data presented below will suggest areas where ADIPRENE L might be useful to you. More complete information is contained in our new booklet. Send the coupon today for your copy. E. I. du Pont de Nemours & Co. (Inc.), Elastomer Chemicals Dept. MM-10, Wilmington 98, Del.

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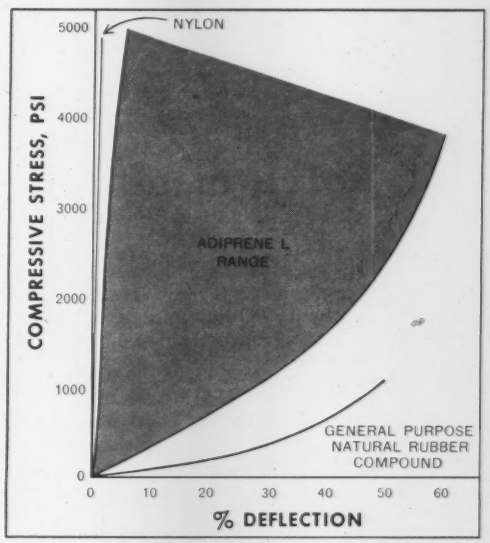

LOAD BEARING CAPACITY of hard ADIPRENE L compounds (shaded area of curve) ranges between that of general-purpose rubber and the harder plastics.

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How Ryerson helped Stainless buyer solve missile component problem

Titanium stringers in stainless forged bars were recently creating a difficult problem for a manufacturer of missile parts. This company's first step in solving the problem: call in a Ryerson representative.

Selection of the wrong type of stainless was found to be the cause of the trouble. The Ryerson man pointed out that stringers are inherent in Type 321 stainless then being used. He recommended switching to Type 347 stainless. Result: the same stabilized corrosion resistance and strength—but no titanium stringers.

This is just one more example of value-analysis teamwork between manufacturers across the country and Ryerson specialists—a close association that increases the value of their metal-buying dollars. Put Ryerson on *your* value-analysis team. A discussion with your Ryerson I.V.B.M. specialist will show how you can get Increased Value in Buying Metals from Ryerson.

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Aluminum bus body *uses thousands of standard and special aluminum fasteners of all types.*

Fasten Aluminum with Aluminum Fasteners

Using aluminum fasteners with aluminum gives products a uniform, stain-free appearance and avoids electrolytic corrosion. Here is the information you need to select standard aluminum fasteners.

by Floyd A. Lewis, *Technical Secretary, The Aluminum Assn.*

■ The light weight and corrosion resistance of aluminum can be just as vital to fasteners as to other parts. Although special aluminum fasteners have been developed for unusual requirements, standard types of rivets, screws, bolts, washers and nuts are available in a wide range of sizes to meet the

majority of fastening needs.

Rivets

Although aluminum rivets can be made in practically any alloy, the eight listed in Table 1 meet most requirements. Alloy 1100 (commercially pure aluminum) is the only non-heat treatable alloy in this group.

In general, rivets to be used with parts of a specific alloy should bear a close relationship to that alloy in mechanical and physical properties. Table 1 shows the more common wrought aluminum alloys for which the rivet alloys and tempers are recommended. Rivet tempers are altered somewhat by the mechanical working which rivets receive when driven and by the natural age hardening to which rivets supplied in the T4 temper are subject.

The selection and proper use of aluminum rivets depend upon many factors, and the essential considerations are summarized in Table 2. Strength properties affecting selection and use are tabulated in tables 3, 4 and 5.

Semi-tubular rivets—Semi-tubular rivets are particularly well suited to automatic riveting. This type of fastening has become popular in the manufacture of such products as storm windows and doors, jalousies, awnings and household appliances. In determining the proper size to use for a given joint, you should realize that, as part of an assembly, semi-tubular rivets are not as strong either in tension or shear as solid rivets of the same alloy and size. The required length is determined by adding the clinch allowance to the total thickness of the material being joined, but, as in the case of solid-shank rivets, the optimum length for a specific job is best determined by trial.

Special rivets—Although standard rivets meet the requirements of the majority of joints, there are also many special types of aluminum rivets. Prominent among these are tubular rivets and a number of designs for blind riveting, where the work is accessible from only one side. Blind

TABLE 1—RIVET ALLOYS AND THEIR USES

Rivet Alloy	Rivet Temper[a]	Used to Rivet These Alloys
1100	-F	1100-all, 3003-O, 5052-O
6053	-T6	6061-T4, -T6; 6063-T4, -T6
	-T61, -T41	Line above + 3003 and 5052, ¼ hard or more
6061	-T6	6061-T4, -T6; 6063-T4, -T6
	-T31	Line above + 3003 and 5052, ¼ hard or more
	-T43	Line above + 2014-T4, -T6; 2024-T4
7277	-T41	6061-T4, -T6; 6063-T4, -T6 + box below
2017	-T31	2014-T4, -T6; 2024-T4; 7075-T6
2117	-T3	Same
2024	-T31	Same

[a]As driven, i.e., including effects of mechanical working and, for the -T4 temper, natural age hardening.

TABLE 2—SOME FACTORS IN SELECTION AND USE OF ALUMINUM RIVETS

Factor ↓	Common Practice	Special Cases	Remarks
Head Style	Cone-point driven heads	Round, button, etc., for appearance or design necessity	Cone-point heads develop full tensile strength of shank, require less stock and less driving pressure than button heads, permit variations in shank length
Diameter, Spacing	Rivet dia no more than three times thickest part of joint; distance from material edge to rivet center at least twice rivet dia; spacing at least three times rivet dia and no more than 24 times joint thickness	Min spacing may depend on driving ease with particular equipment or method used	Spacing and rivet dia must be considered together
Length	Determined by these factors: 1) difference between rivet dia and hole size, 2) total joint thickness, 3) type of driven head, 4) driving conditions, 5) variations in rivet set	—	Best method of determining optimum length is a trial under actual conditions
Hole Clearance	Cold driven rivets require clearances from 0.003 in. for thin material to 0.032 in. for 1-in. material. Hot driven rivets require slightly larger clearances	Clearances must be large enough to permit rapid production insertion	Holes are punched or drilled but, if possible, should have secondary reaming or shaving operations to prevent radial cracks
Driving Method	Squeeze riveters when possible; pneumatic hammers if large enough to upset rivets properly; heavy hammer if adequate bucking is possible	Automatic machine riveters will handle rivets to 5/32-in. dia and punch stock to 5/32-in. thk	Actual driving tests should be used to determine hammer sizes
Driving Temperature	Non-heat treated rivets and alloy 2024, 2117 rivets driven cold; alloys 6053 and 6061 usually driven cold but sometimes hot if over 1/2-in. dia; alloy 7277 always driven hot	—	Because age hardening begins immediately after heat treatment, alloys 2017, 2024 and 6061 are re-heat treated immediately before driving (see below)
Re-Heat Treatment	Heat for 10-30 min depending on size and number of rivets; water quench immediately. Temperature depends on alloy: 2024, 910-930 F; 2017, 930-950 F; 6061, 950-980 F	—	Age hardening begins immediately but rivets can be driven in first hour or two without refrigerated storage

TABLE 3—SHEAR STRENGTH OF DRIVEN RIVETS[a]

Rivet Alloy	Predriven Temper[b]	Driving Condition	How Driven	Driven Temper	Shear Str, 1000 psi
1100	-F	As Is	Cold	-F	11
2017	-T4	As Is	Cold	-T3	39
		Quenched	Cold	-T31	34[c]
2024	-T4	Quenched	Cold	-T31	42[c]
2117	-T4	As Is	Cold	-T3	33
6053	-T61	As Is	Cold	-T61	23
6061	-T6	As Is	Cold	-T6	30
	-T4	Quenched	Cold	-T31	24[d]
		Heat Treated	Hot	-T43	24[d]
7277	-T4	Heat Treated	Hot	-T41	38[e]

[a] With cone-point heads; heads requiring more pressure develop slightly higher strengths.
[b] As ordered. [c] After four days; immediate strength is 75% of value indicated.
[d] After two weeks; immediate strength is 75% of value indicated.
[e] After one week; immediate strength is 75% of value indicated.

TABLE 4—TYPICAL STRENGTHS OF RIVETED ALUMINUM ALLOYS

Alloy	Temper	Tensile Str, 1000 psi	Yield Str, 1000 psi[a]	Bearing Str, 1000 psi[b]	Bearing Yld Str, 1000 psi[c]
1100	-O	13	5	21, 27	10, 12
	-H12	16	15	24, 30	19, 23
	-H14	18	17	26, 32	22, 26
	-H16	21	20	28, 34	24, 28
	-H18	24	22	31, 38	28, 33
3003	-O	16	6	25, 34	12, 15
	-H12	19	18	28, 37	24, 27
	-H14	22	21	31, 39	26, 31
	-H16	26	25	34, 42	29, 35
	-H18	29	27	38, 46	33, 40
2014	-T4	62	42	93, 118	56, 64
	-T4[d]	61	37	91, 116	52, 60
	-T6	70	60	105, 133	84, 96
	-T6[d]	68	60	102, 129	84, 96
2024	-T4	68	47	102, 129	67, 77
	-T4[d]	64	42	96, 122	59, 67
	-T36	72	57	110, 139	80, 91
	-T36[d]	67	53	100, 127	74, 85
5052	-O	28	13	43, 57	21, 26
	-H32	33	28	54, 71	38, 43
	-H34	38	31	59, 78	44, 50
	-H36	40	35	62, 82	47, 54
	-H38	42	37	66, 86	50, 58
6061	-T4	35	21	56, 73	29, 34
	-T6	42	40	72, 94	56, 64
7075	-T6	83	73	123, 156	101, 115
	-T6[d]	76	67	114, 144	94, 107

[a] At 0.2% offset.
[b] First value is for an edge distance of 1.5 rivet dia, second value for distance of 2 dia.
[c] At set of 2% of hole dia. First value is for an edge distance of 1.5 rivet dia, second value for distance of 2 dia.
[d] Alclad.

rivets include Chobert, Huck, Cherry, and Du Pont explosive rivets.

Screws and bolts

Practically all standard types and sizes of screws and bolts used in the assembly of fabricated metal products are available in aluminum. In addition, many special types are made to meet special requirements.

Alloys—Like rivets, screws and bolts can be made from almost any aluminum alloy. However, practically all of the standard screws and bolts are made from alloy 2024-T4. Experience has shown that this high strength, heat treated alloy has the best combination of strength and resistance to corrosion for general service. Other alloys may be used for special applications.

Screw types—A full range of heads is available in aluminum machine screws—flat, round and oval, as well as the less common fillister, pan, truss, washer and other heads. Standard machine screws are made with either slotted heads or heads having the Phillips-type recess. Screws with special types of heads are available on order. Wood screws of aluminum are produced in round, flat, oval and other head styles, either slotted or with Phillips recess.

Bolt types—Aluminum bolts are made in various standard types, the most common being the hexagon-head and carriage types. Hexagon-head bolts are either "regular" or "finished." The heads of the "regular" are not washer-faced and are the most commonly used bolts for general purpose work. The "finished" have washer-faced heads and are also called hexagon-head cap screws. These are used 1) in place of regular bolts where a washer face is required to seat against a spot-faced or finished surface, 2) in tapped holes, or 3) where it is necessary to wrench up the bolt head rather than the nut. Carriage bolts, generally with round head and square neck, are used in fastening wood or other soft materials.

Threads—As with other metals, threads on aluminum screws and bolts may be either rolled or cut. Any type of thread may be specified, but the vast majority of aluminum screws and bolts made in the United States have American Standard threads.

Holes—Bolt and screw holes can be punched, drilled or reamed. Where stresses are light and vibration is not a factor, punching or drilling is usually adequate. Reaming is recommended for highly stressed joints subject to vibration. Clearance between hole and bolt or screw should not be more than 3% of the bolt diameter, preferably less for highly stressed joints.

Screw strengths—Table 6 gives the results of tests on machine screws to determine the tensile strength and torque strength to

rupture. These were static tests. Since aluminum alloys are more subject to notch sensitivity than steel or brass, a lower fatigue-to-tensile strength ratio is obtained. The figures on torque strength are based on holding the screw shank in a vise and twisting the head off with a torque screw driver.

Screws made from alloy 2024-T4 are roughly as strong as brass screws. Neither are as strong as stainless steel screws. As a rule of thumb, aluminum screws may be used size for size in place of brass screws and one size larger in place of stainless steel screws. Of course, a larger size is not necessary when the steel fastener is stronger than design requirements.

Bolt strengths—Table 7 gives the nominal breaking strength values determined from tensile tests on bolts of various sizes. In installing any type of bolt it is important that stress be kept within the yield strength of the material. The design of most products is such that no special problems are involved. But in heavy-duty applications involving high working stresses it is important that bolts not be stressed beyond a point which will cause the total stresses on them to exceed permissable limits.

For such applications it is recommended that several bolts be assembled with a torque wrench until failure occurs. Production assembly then should be carried on with an applied torque at not over 70% of the breaking torque determined on the test bolts. This will insure adequate clamping load being applied. Since there may be wide variations of friction due to roughness of clamped surfaces, lubrication of the threads, etc., this trial method based on actual conditions will give a better criterion of torque required than arbitrary recommended torque strength values.

At the same applied torque, aluminum bolts have a greater clamping strength than steel bolts. Tests run on ⅜-in. dia bolts show that the same clamping load is obtained with a torque of 135-145 in-lb on 2024-T4 bolts or 250-275 in-lb on steel bolts.

TABLE 5—RIVET SHEAR STRENGTH LOSS IN THIN PLATES

Single Shear Joint		Double Shear Joint[a]			
Ratio[b]	Loss, %	Ratio[c]	Loss, %	Ratio[c]	Loss, %
3.0	0.0	1.5	0.0	2.8	16.9
3.1	0.4	1.6	1.3	2.9	18.2
3.2	0.8	1.7	2.6	3.0	19.5
3.3	1.2	1.8	3.9	3.1	20.8
3.4	1.6	1.9	5.2	3.2	22.1
3.5	2.0	2.0	6.5	3.3	23.4
3.6	2.4	2.1	7.8	3.4	24.7
3.7	2.8	2.2	9.1	3.5	26.0
3.8	3.2	2.3	10.4	3.6	27.3
3.9	3.6	2.4	11.7	3.7	28.6
4.0	4.0	2.5	13.0	3.8	29.9
		2.6	14.3	3.9	31.2
		2.7	15.6	4.0	32.5

[a]If the single shear joint ratio gives larger loss, use that value.
[b]Ratio of rivet dia to thinner outside plate. [c]Ratio of rivet dia to inside plate.

TABLE 6—RUPTURE STRENGTHS FOR MACHINE SCREWS

Size	Material	Tensile Strength, lb	Torque Strength, lb
No. 6	Al 2024-T4	596	10.5
	Brass	635	11
	Stainless 430	775	15.2
	Stainless 304	970	19.5
No. 8	Al 2024-T4	904	19
	Brass	930	21
	Stainless 430	1099	25.7
	Stainless 304	1450	45
No. 10	Al 2024-T4	1120	27
	Brass	1225	35
	Stainless 430	1425	45
	Stainless 304	1780	65
¼ in.	Al 2024-T4	2025	70
	Brass	2050	76
	Stainless 430	2587	101
	Stainless 304	3380	133

TABLE 7—BOLT BREAKING STRENGTHS

Bolt Size	Strength, 1000 lb
¼-20	2.025
5/16-18	3.30
⅜-16	5.00
½-13	8.70
⅝-11	14.30
¾-10	20.75

Nuts

As with bolts and screws, a full variety of nuts is manufactured in aluminum. These include standard hexagonal nuts, which are by far the most popular; also square, cap, wing, knurled and castellated types, plus many of the special stop or locknut variety. In the larger sizes, nuts made from alloy 6061-T6 are recommended since they provide better resistance to corrosion, including stress corrosion, and also develop the full strength of the bolt.

Sheet-metal screws

Aluminum sheet-metal screws are used in the assembly of a wide variety of products made from aluminum sheet and extrusions—from small items such as toys to larger products including ductwork for heating, ventilating and air conditioning; bus, truck and trailer bodies; awnings and venetian blinds. Because sheet-metal screws are simply driven into pierced or drilled holes of proper

size, their use eliminates costly tapping operations and permits a secure threaded fastening in locations accessible from only one side.

Alloys—In this method of fastening the screw displaces metal in the part into which it is driven. In order to accomplish this the screw must be harder and stronger than the metal in the parts being fastened together. Thus, aluminum sheet-metal screws are limited generally to use with the softer aluminum alloys, such as 1100, 3003, 5052 and 6063. They could not be used, for example, with 2024-T4 sheet since the screw itself is produced from this alloy and in this temper.

Types—Aluminum sheet-metal screws are supplied in two types. The type "A" or gimlet-point type is used for the lighter gages of sheet; the type "B" or blunt-point type is used in heavier gages of sheet, as well as to fasten sheet to extruded sections or castings. Both types are available in a variety of head styles, both slotted and with Phillips recess.

Other uses — Although aluminum sheet-metal screws are designed primarily for fastening aluminum to aluminum, they are also widely used to fasten aluminum sheet to such other materials as plastics, fiber and wood.

Washers

Three basic types of washers are available for aluminum fasteners — plain, finishing and spring lock.

Plain washers normally are used for decorative purposes, to protect part surfaces from damage, and to spread the load imposed by the fastener over a wider area of the parts being joined.

Finishing washers are designed for use with standard flat or oval countersunk head screws and serve the normal function of a washer, but with improved appearance. They are frequently used on such items as furniture where they seat on wood, or on leather or fabric coverings.

Screwed or bolted connections may be secured against vibration by means of aluminum alloy spring lockwashers. Thus vibration resistant joints can be assembled completely with aluminum components.

Fastener finishes

Aluminum fasteners accept the same broad range of finishes as other aluminum parts. These include various types of mechanical finishes, chemical and electrochemical finishes, paint, enamel and lacquer. In some instances rivets or other types of aluminum fasteners are given anodically applied oxide finishes for increased resistance to corrosion, abrasion or wear. Others are given dyed finishes for identification purposes to distinguish fasteners of one alloy from those made of another. For products that are finished after assembly, exposed surfaces of fasteners can receive the same finishes as other aluminum parts, preserving uniformity of appearance.

Variety of head styles *available in aluminum fasteners is apparent in this collection of wood screws.*

For products requiring high resistance to strong acids, alkalis and solvents . . .

Furane Coatings

by John Delmonte, *Furane Plastics, Inc.*

PROPERTIES OF FURANE COATINGS

Type ➡	Acid-Catalyzed Furane	Baked Furane-Epoxy
CHEMICAL RESISTANCE		
Exterior Durability	Good	Good
Salt Spray	Exc	Exc
Solvents		
Alcohols	Exc	Exc
Gasoline	Exc	Exc
Hydrocarbons	Exc	Exc
Esters	Exc	Exc
Ketones	Exc	Good
Chlorinated	Exc	Exc
Beverages, Foods	Exc	Exc
Salts	Exc	Exc
Alkalis	Exc	Exc
Ammonia	Exc	Good
Acids		
Oxidizing	Poor	Poor
Formic	Fair	Fair
Fatty	Exc	Exc
Phosphoric	Exc	Exc
Water (salt, fresh)	Fair	Exc
PHYSICAL PROPERTIES		
Viscosity (75 F), cp	300	20
Flexibility	Fair	Fair
Max Svc Temp, F	250	400
Toxicity	None	None
Dielectric Properties	Poor	Good
Adhesion to—		
Metals	Poor	Exc
Ceramics	Good	Exc
Old Paint	Good	Good
DECORATIVE PROPERTIES		
Choice of Colors	Limited	Limited
Color Retention	Good	Good
Initial Gloss	Exc	Exc
Gloss Retention	Fair	Good
APPLICATION		
Ease of Application	Good	Exc
Metal Surface Prep	Primer	No primer
Solvent Used	None	Ketone
Methods	All	All
Cure	Air or bake	Bake
Bake Drying Time	10 hr (200 F)	1 hr (325 F)
Air Drying Times		
Touch	3 hr	15 min
Handle	5 hr	1 hr
Re-Coat	5 hr	1 hr
Corr Res	1 week	After bake
Coverage, sq ft/gal/mil	500	300
Coat Thk (avg), mil	3.0	0.5

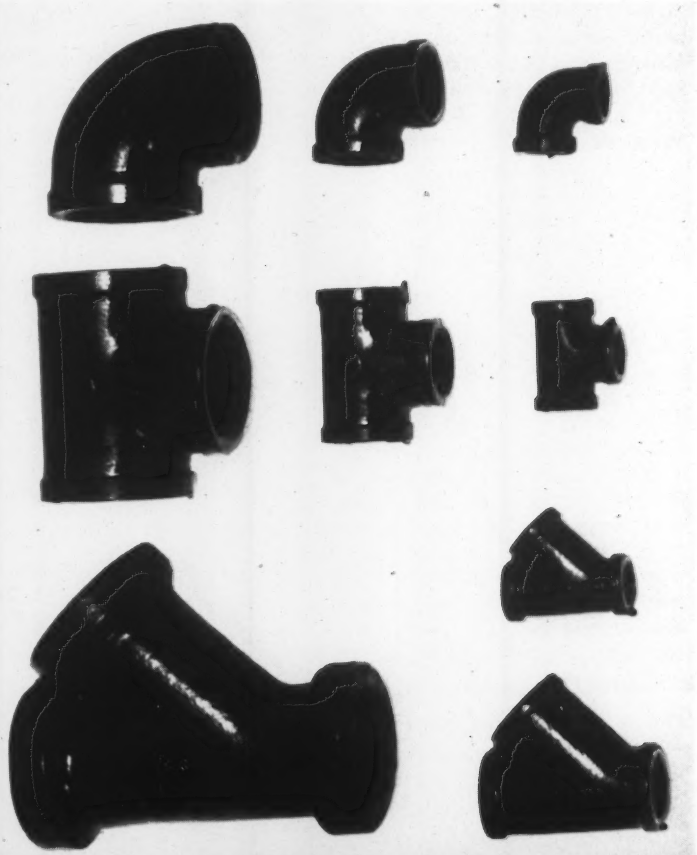
■ As shown in the table, furane coatings can be formulated with exceptionally good chemical resistance. They have good resistance to solvents, foods and beverages, salts, alkalis, and many acids with the exception of oxidizing acids and formic acid. Naturally, no hard and fast rules can be laid down as to their corrosion resistance in specific applications. Consequently, as with other organic coatings, furane coating samples should be evaluated under simulated service conditions.

Properties and cost

Aside from chemical resistance properties, furane coatings have three special characteristics of particular interest to the engineer —color, adhesion and cost.

Color—Little can be done to a true furane coating to produce colors. Although furfuryl alcohol can be re-distilled to a water-white clarity, the coatings assume a dark color upon exposure to air, catalysts or baking. Thus, most industrial uses for furane coatings are confined to a black color. Coat-

Pipe fittings *used in contact with corrosives are effectively protected with two or three coats of glossy black, baked furane coating.*



ings are usually glossy; however, a dull or matte finish can be obtained by adding a silica-type filler.

Adhesion—In general, an acid-catalyzed furane coating does not have satisfactory adhesion to metal surfaces. However, because of its high penetration this type of coating has good adhesion to semi-porous surfaces such as wood, masonite and transonite. Excellent adhesion to steel, aluminum and magnesium surfaces can be obtained by using a baked solvent-type furane coating. The good adhesion of this coating is borne out by its use as a primer for other metal coatings.

Cost—An important limitation of furane coatings is that they cost more than conventional organic coatings such as epoxies and phenolics. However, where special resistance properties are needed, furane coatings may be cheaper in the long run. Where this possibility exists, the coatings formulator should be consulted to determine the best and least expensive coating system.

Applications

Laboratory furniture — Furane coatings have been singularly successful in the coating of chemical laboratory furniture. All the coatings are not perfect, but compared to other organic coatings they provide the best all-around resistance to a variety of acids, alkalis and solvents. Furane coatings have good resistance to strong acids such as hydrochloric, sulfuric (up to 60%) and hydrofluoric acids; however, they are attacked by oxidizing acids such as concentrated nitric acid. The coatings have an attractive black, glossy finish which can be changed to a satin finish by light sanding.

Chemical processing tanks—Because of their inherent chemical resistance, furane coatings can provide good protection on processing tanks. Although solventless-type furane coatings have poor adhesion to steel tanks, this difficulty can be overcome by applying the coatings over a suitable primer. Primers based on phenolic-synthetic rubber bases are particularly recommended to promote adhesion. A careful and complete cure must be produced for the coating system to be fully effective.

A glass fiber reinforcement can be used with furane coating materials to produce a lining with improved protective properties and with a coefficient of expansion closely matching that of steel. For best results, a large thin sheet of an acrylonitrile or vinyl fabric should be used to seal the glass cloth against possible wicking. This type of lining system has been effectively used on tanks exposed to strong mineral acids and aliphatic solvents at high temperatures.

Furane coatings are also effective in increasing the chemical resistance (especially to alkalis and solvents) of glass-polyester tanks. The only pretreatment required is cleaning and sanding. Alternatively, the coating can be incorporated into the tank surface right in the lay-up manufacturing process. This is done by applying the coating directly to the mold before the glass-polyester (or glass-epoxy) backup is applied.

Hardware, valves, fittings—Two or three dip applications of a furane coating can effectively increase the chemical resistance of standard hardware, fittings (see photo), threaded assemblies, rods, sheets and other parts. Applied from a low viscosity solution, these coatings (about ½ mil thick per dip) have excellent adhesion and chemical resistance after baking. They have proved quite effective on steel and copper parts (such as molds used for dipping and casting of vinyl plastisols) exposed to corrosives at high temperatures.

Coatings for plaster — Thin, penetrating furane coatings can be used on plaster parts to improve their chemical and heat resistance, as well as their mechanical strength. A significant increase in the durability and effectiveness of plaster molds and forms can be obtained by this type of treatment.

Three Types of Furanes

Furane resin coatings can be divided into three types:

A thin penetrating coating that cures with the aid of catalysts and baking.

A medium viscosity coating that cures with catalysts.

A solvent-type coating that cures by baking. The furane resins in this type of coating can be combined with epoxy resins to produce a furane-epoxy copolymer coating.

Because of their chemical structure, furane resin prepolymers can form coatings with a 100% solids content which do not contain any solvents. These coatings—characterized by the first two types above—are cured by using a catalyst alone or by using a catalyst in conjunction with baking.

The catalysts used with furane resins are generally acidic, preferably paratoluene, sulfonic acid, phosphoric acid, or other strong organic acids. The presence of these acid catalysts can be corrosive to metal parts. This disadvantage can be avoided by specifying baking-type coatings which can be formulated with little or no acid catalyst.

Processing tank interior *is coated to resist hot acids and solvents.*

Solid Urethane Elastomers

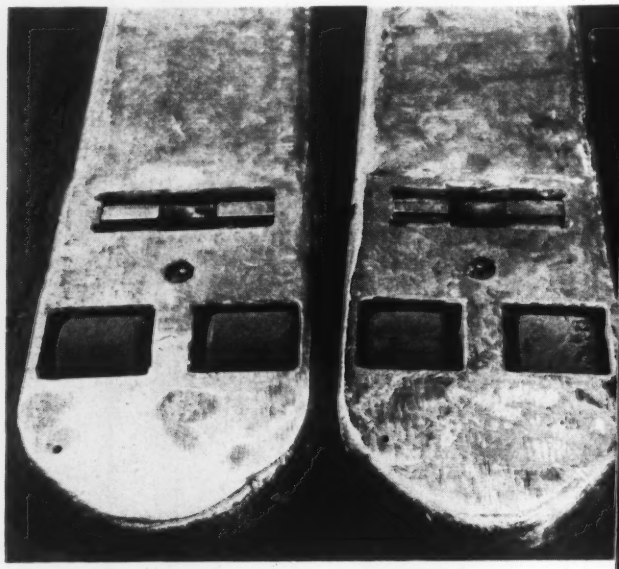
by Malcolm W. Riley, *Associate Editor, Materials in Design Engineering*

After several years of development and publicity they are becoming accepted engineering materials. Here are details on six well-engineered commercial uses. For more information on these materials, see the following pages.

All case histories shown on these two pages, except the nose-piece insert for the sand rammer, were supplied by Disogrin Industries, Inc.

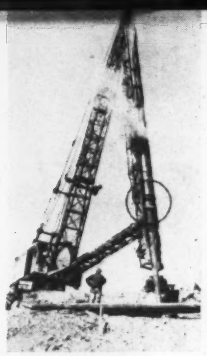
Traction drive wheels

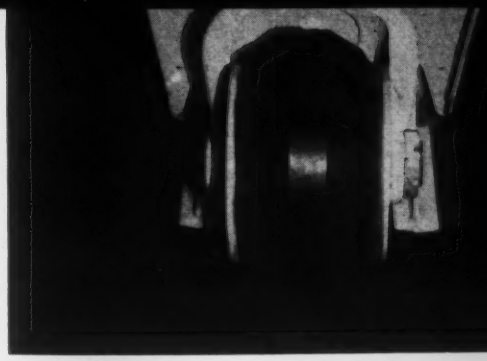
■ *LOAD-BEARING ABILITY, ABRASION RESISTANCE*—The eight 14 x 4-in. traction drive wheels for machines used by H. C. Price Co. to apply protective coatings to pipe must 1) sustain loads of 1500-5000 psi, depending on pipe size, and 2) drive the pipe at linear speeds varying from 50 fpm for smaller pipe to 10 fpm for larger pipe. Rubber wheels "chunked out" or peeled off hubs. Urethane tires cast by Disogrin were installed in Sept '57. ■ *RESULTS*—After a full year of operation, the original eight wheels are still in service, with no chipping or grooving. Wheel diameter was reduced only ½ in. whereas average life of rubber wheels was no more than three to four weeks (e.g., wheel held by operator in photo). Urethane wheels shown on machine have been in service for over one year.



Pallet truck wheels

■ *LOAD-CARRYING ABILITY, RESILIENCE, STRENGTH*—Pallet trucks in shipping and receiving department of Rexall Drug Co. must have 1) high load bearing ability, 2) wear and abrasion resistance, 3) resistance to tearing or chunking caused by sharp steel plates, and 4) resilience, so as not to damage flooring. Urethane wheels cast by Disogrin have been in operation for about one year. ■ *RESULTS*—Photo shows urethane-treaded wheels (left) after more than a year's service. Rubber wheels at right which are about to be discarded have been in use for about three months.



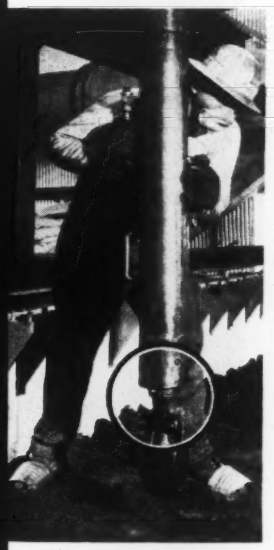


Vibration damper for pile hammer

■ *RESILIENCE, HIGH HYSTERESIS, OIL RESISTANCE*—Dampers must eliminate metal-metal contact caused by vibration when ram hits anvil of this 20-ton Mckiernan-Terry pile hammer. Combination of impact loading, attack by hydraulic fluid and 180-200 F heat build-up caused "breakout" of previously used damper materials, such as natural rubber and neoprene. Urethane damper cast by Disogrin in use now about 1½ yr. ■ *RESULTS*—Damper life estimated by user to have been doubled. Previous dampers lasted from four to six months; the downtime to replace a damper cost $180-240. First urethane damper installed approximately 1½ years ago is still in service.

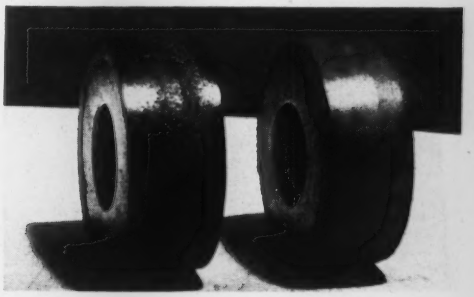
Tail 'skid' wheel

■ *STRENGTH, ABRASION RESISTANCE, RESILIENCE*—Tail wheels for Douglas F4D Skyray must withstand 1) high impact drag loads during shore-based field landing and FCLP's (field carrier landing practice), 2) tearing and burning, should tail wheel axle freeze, and 3) impact of tail wheel hitting arresting cable during carrier landing. Urethane wheels cast by Disogrin replace natural rubber wheels. ■ *RESULTS*—Wheel life increased about four to five times that of rubber. Cost of wheel assembly increased only 10%. One wheel withstood total of 140 landings (58 FCLP's, 33 arrested landings, 49 field landings) before small chunk was knocked off wheel; at that time only 3/16 in. had worn off wheel periphery. Results of five wheel tests indicate average life of 46 landings per wheel (50% FCLP's, 28% arrested landings, 22% field landings).



Nose-piece inserts for sand rammer

■ *ABRASION RESISTANCE, RESILIENCE, TOUGHNESS*—Cast urethane inserts form tough, wear resistant liners in the nose pieces of these pneumatic Keller Sand Rammers, used by Ormet Corp. to tamp linings into electrolytic aluminum separation cells. Photo at right shows nose-piece casting with poured insert developed jointly with Mobay Chemical Co. Above it is previously used unlined casting chipped and worn by metal-metal contact between casting and hexagonal tamping rod. ■ *RESULTS*—Inserts resulted in 1) two-thirds reduction in rammer maintenance; 2) saving of nearly $1000 in a three month period for replacement parts; and 3) elimination of need for two mechanics to service tampers. All-metal nose pieces lasted two months; graphitized lead packings lasted from one to four weeks. Inserts, as well as packing rings which replaced lead packings, show no sign of wear after four months service.



Contact wheel for grinder

■ *WEAR RESISTANCE, DIMENSIONAL STABILITY*—Contact wheels used in grinding airfoil sections of turbine blades at Utica Drop Forge must maintain high degree of accuracy during grinding, i.e., wheels must be replaced when wear reduces diameter by 0.010 in. The high (1300 rpm) speed of wheel plus constant pressure of blade caused rapid wear and loss of wheel contour in previously used neoprene wheels. Various plastics were tested unsuccessfully. Urethane wheels cast by Disogrin now in use for about three years. Photo shows worn neoprene wheel (left); urethane wheel (right). ■ *RESULTS*—Urethane doubled wheel life, maintaining tolerances and dimensions for machining of forty blades; the neoprene wheel lasted only twenty blades.

Properties of urethane elastomers—see next page. Cable splicing with urethane elastomers—see p 97

Urethane elastomers . . .

Hard, resilient, tough, abrasion resistant . . . Here is a summary of the types available and what they have to offer.

■ The first volume uses for solid urethane elastomers were restricted to materials handling truck wheels and shoe lifts. Here the elastomer's excellent abrasion resistance and toughness provided 3 to 10 times the service life of other elastomers.

Now, with processing problems being solved, prices coming down, and design information becoming reliably standardized, the materials are branching out into a variety of well-engineered applications (for examples, see previous two pages).

The materials' full potential is far from being realized yet, as indicated by the shroud of secrecy covering developmental products. But the elastomers seem well on the way to becoming established engineering materials.

Potential applications, in varying stages of commercial development, include potting and encapsulation, silent tooth and friction gears, abrasion resistant lining, and flexible power transmission couplings, to mention just a few.

Four types available

Four basic types of urethane elastomers are currently available: 1) cast polyester, 2) cast polyether, 3) millable gum (both polyether and polyester are available) and 4) thermoplastic polyester.

The first two—liquid cast urethane elastomers—appear to be the most widely used types today, by far. They can be gravity cast and centrifugally cast, and most types can be compression molded. Liquid casting provides obvious advantages for fabricators lacking the costly equipment required for milling and compounding conventional elastomers. The recent development of continuous casting machines (or in some cases the adaptation of epoxy metering and casting machines) should substantially im-

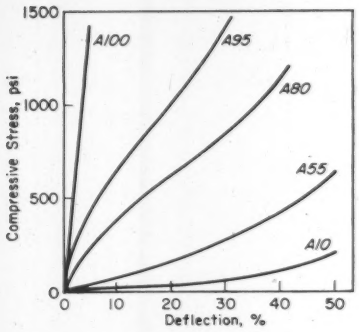


***Fig 1**—High load-bearing capacity is shown by these compression-deflection curves for five Shore A hardnesses of cast polyether-type elastomer.* (E. I. du Pont de Nemours & Co., Inc.)

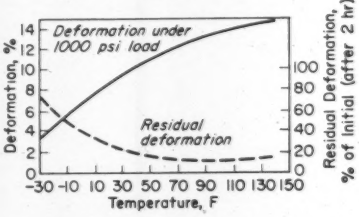


***Fig 2**—Effect of temperature on deformation under load and recovery for a Shore A92 polyester-type urethane.* (Disogrin Industries, Inc.)

TYPICAL PROPERTIES OF URETHANE ELASTOMERS[a]

		Type →	Cast[b]							
			Polyether Type[c]				Polyester Type[d]			
		Hardness (Shore) →	A10-40	A45-75	A88-98	D68-75	A60-73	A78-83	A88-92	A93-98
	ASTM									
Ultimate Ten Str, psi	D412		250-425	600-4500	3900-5000	4000-8000[g]	4000-6000	4500-8000	4000-6500	4000-5500
Ultimate Elong, %	D412		425-1000	430-700	200-480	120-270[g]	550-650	500-800	475-700	450-600
Modulus, psi										
100%	D412		—	—	750-1950	3000-3700	250-600	475-925	1000-1700	1200-1600
300%	D412		40-225	150-1100	2100-4400	—	625-1650	1400-2500	1600-3200	2100-3000
Permanent Set, %										
Elong Set at Break	D412		—	—	—	—	0-50	3-15	20-50	20-50
Compr Set (Method B, 22 hr at 158 F)	D395		2-34	7-40	—	—	1-25	20-25	20-25	20-25
Tear Strength (Graves), lb/in.	D624		< 20	50-225	475-750	—	280-320	450-525	550-600	550-700
Resilience, %										
Rebound	—		—	—	42-48	—	45-50	50-60	45-50	45-50
Yerzley	D945		—	65-80	75[f]	—	—	—	—	—

[a] Each hardness range covers several commercial grades.
[b] Most of these liquid cast types can also be compression molded.
[c] Typified by properties given here for Adiprene L (Du Pont).
[d] Typical ranges given are for 1) formulations based on Multrathane (Mobay Chemical Co.), 2) Disogrin (Disogrin Industries, Inc.), 3) Daycollan (American Latex Products Corp., division of Dayton Rubber Co.), 4) Elastacast (Acushnet Process Co.), 5) Neothane (Goodyear Tire & Rubber Co.).
[e] Estane 5740X1 (B. F. Goodrich Chemical Co.).
[f] 75% value is for A89 durometer stock; at hardness of A95 stock is too hard for reading.
[g] Crosshead speed of 1 ipm; ASTM method is 20 ipm.

prove casting economies. Liquid cast materials cost about $0.90 to $1.60 per lb, depending on volume ($2 to $4 per 100 cu in.).

The millable gum obviously offers particular advantages for those producers who have rubber processing equipment. It is both compounded and formed by conventional rubber processing techniques. Millable gum stocks are available at about $1.50 per lb.

The thermoplastic urethane elastomer is a recent entry. It is a "virtually crosslinked" polyester type, designed for processing on conventional thermoplastic processing equipment, e.g., extrusion, molding, milling and calendering. It can also be processed by solution techniques. The material can be plasticized and compounded to provide a wide range of properties. It seems most promising for extruded jacketing for wire and cable, hose and small bore tubing, coatings for fabrics, sheet for lining equipment, and film for packaging. The material is available in experimental quantities at an introductory price of $1.85 per lb.

Mechanical properties

In spite of the differences among the four types of urethane elastomers, they all have certain similarities in properties. The mechanical properties given in the table are cited as typical by the producers who furnished the data (see footnotes). However, properties of specific compounds can be altered extensively by compounding or by changing the cure. Thus, the following discussion is intended only to indicate general, comparative orders of magnitude. Properties of compounds available to meet specific materials specifications should be obtained from materials suppliers.

Hardness and strength—The most commonly used urethane elastomers usually range in Shore durometer hardness from A60 to A90. As can be seen in the table, hardnesses are available ranging from as low as A10 to as high as D75, in the recently developed compounds. Highest practical hardness of other natural or synthetic rubbers is about A75-80. In spite of their hardness, urethanes have elongations of 400 to 700%, and even the extremely hard compounds have elongations of 120 to 270%. Rebound elasticity ranges from 45 to 60% in the harder grades.

Urethanes probably have the highest gum tensile strengths obtainable in elastomers, e.g., 4000 to 8000 psi, with 300% moduli of 1400 to 3200 psi. Natural and synthetic rubbers must be reinforced with filler to obtain tensile strength values as high as 3000 to 4500 psi and 300% moduli of 1000 to 3000 psi.

Tear strengths of urethane elastomers are exceptionally high, and account for many of the benefits in use, such as resistance to "chunking" and peeling. Also, tear strength increases with hardness. Values as high as 600 to 700 lb per in. are obtainable.

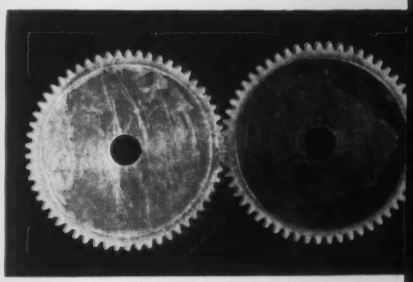
Load carrying ability is shown by the curves in Fig 1, 2 and 3. Fig 1 shows compression-deflection characteristics on one type of cast urethane at five different hardnesses. Fig 2 shows deformation under load and residual deformation after 2 hr for a Shore A92 hardness stock. Fig 3 compares the compressive stress

	Millable Gum		Thermoplastic Polyester Type[a]
	A62-66[b]	A70-95[b]	A85
	3150-5150	3600-4500	6200-8000
	450-550	315-450	600
	—	—	800
	1700-2475	2750-3250	1200-1500
	—	—	—
	18-21	14-47	87
	260-380	—	430
	69	—	—
	56-57	—	78

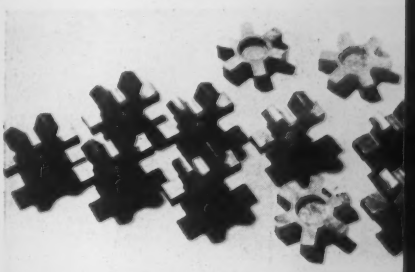
[b]Black reinforced; range covers Adiprene C (Du Pont) and Genthane S (General Tire and Rubber Co.).
[a]Typical range of properties obtainable with resin reinforcement in Genthane S (General Tire and Rubber Co.).

Here are good potential uses

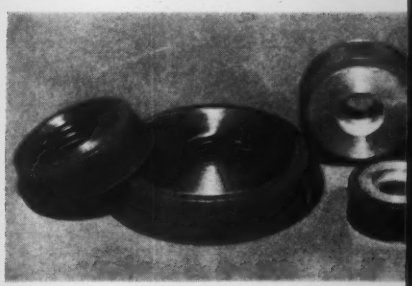
Photos courtesy American Latex Products Corp., Div. of Dayton Rubber Co.



Silent insulated gears



Inserts for power transmission couplings



Bevel friction gears

Nozzle liner for abrasive slurry separator

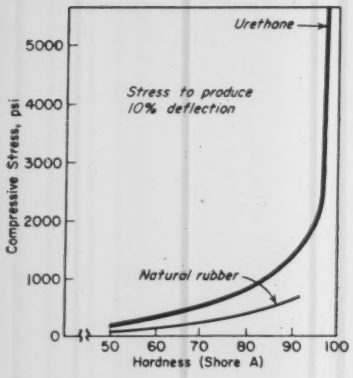


***Fig 3**—How hardness affects the compressive load needed to produce a 10% deflection in a polyether-type urethane, compared with natural rubber.* (E. I. du Pont de Nemours & Co., Inc.)

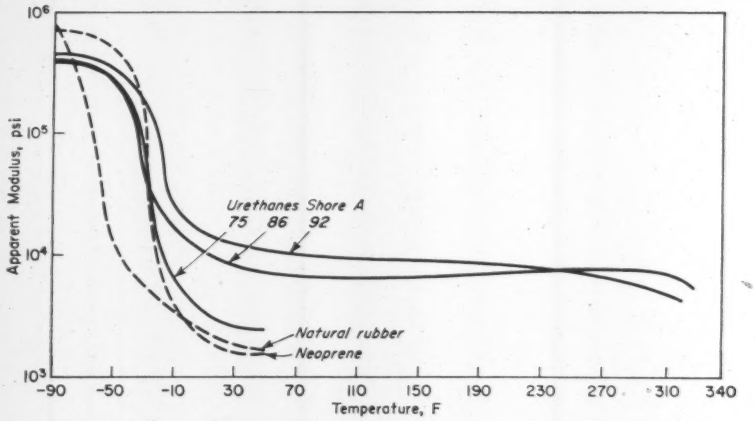


***Fig 5**—How temperature affects torsional stiffness* (Clash-Berg) *of urethanes, compared with natural rubber and neoprene.* (Mobay Chemical Co.)

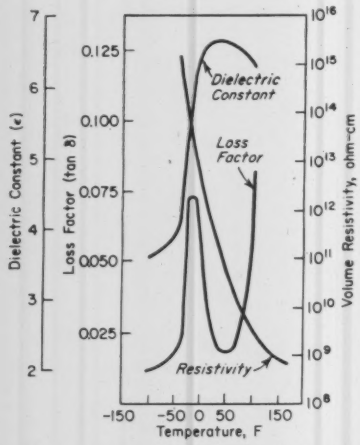


***Fig 4**—Typical electrical properties of urethane (Shore A92 polyester-type; frequency 800 cps).*
(Disogrin Industries, Inc.)

needed to produce 10% deformation in urethane and natural rubber at various hardnesses.

Abrasion resistance—Resistance to abrasion and wear is one of the most notable attributes of urethane elastomers. Standard tests for measuring this property are quite unsatisfactory. The best indication of this property can be obtained from the case histories on the previous pages.

Hysteresis—Urethanes are characterized by relatively high hysteresis, which can be of benefit in such applications as impact or vibration damping. However, the resulting rapid temperature rise must be limited by careful design. Fortunately, the high load bearing capacity and strength of urethanes usually permit use of thinner sections than with other types of elastomers. Properly designed, such thinner sections can avoid deleterious temperature increase during flexing service.

Physical properties

Density of urethane elastomers is typically 77-79 lb per cu ft. This low weight brings the materials cost on a volume basis closer to that of metals.

Thermal conductivity is about 1.6 Btu/hr/sq ft/°F/in., and coefficient of linear thermal expansion ranges typically from about 80 to 110 x 10^{-6} per °F. Specific heat is about 0.42-0.44 Btu per lb.

Electrical insulating properties are of the same general order of magnitude as those of phenolics. Harder grades are generally superior in this respect to the softer grades. Typical electrical characteristics are shown in Fig 4.

Effects of environments

Urethane elastomers are limited to maximum continuous use temperatures of about 190 to 220 F, depending on specific conditions of use and the compound being considered. In oil the materials can generally be used at slightly higher temperatures—on the order of 250 F.

At the other end of the temperature scale, urethane elastomers have excellent low temperature properties. They stiffen increasingly at temperatures below about —30 F, but do not become brittle at temperatures as low as —80 F. Fig 5 shows how temperature affects the stiffness of several grades of a polyester-type cast urethane, compared with natural rubber and neoprene.

Urethanes are resistant to a wide range of chemicals. They have excellent resistance to aliphatic solvents, alcohols, ether, most petroleum-based fuels and oils, hydraulic fluids, edible fats and oils, and mixtures containing less than 80% aromatics.

Urethanes swell, and some may degrade, in esters, ketones, pure aromatic compounds, strong or concentrated acids and bases, and very strong oxidizing agents. Service tests should be carried out to determine specific effects on each type.

Most urethane elastomers are unaffected by cold water, but hot water or steam weaken and eventually destroy the materials.

Urethanes have excellent resistance to oxygen and ozone. Though they discolor on exposure to light, their physical properties remain unaffected.

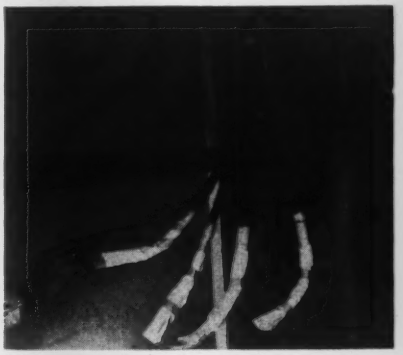
How to make cable splices with cast urethane elastomers

Protective materials for cable splices or breakouts must 1) insulate electrically, 2) prevent corrosion, 3) protect the cable or wires from abrasion, vibration and shock, and 4) protect the cable from moisture or other environments.

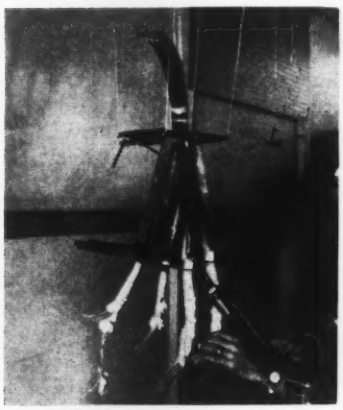
Cast urethane elastomers have the properties needed to serve all these functions extremely well. In addition, they are liquid at room temperature.

Here's how cable splicing is done at Coast Pro-Seal & Mfg. Co. . . .

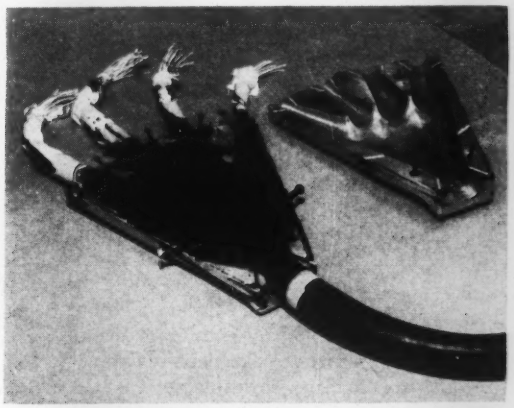
***1. Aluminum molds** are most commonly used today, particularly for quantity production. Mold shown for this multiple-finger breakout is properly vented and ready to be coated with TFE fluorocarbon release. Cable jacketing is then abraded, cleaned and primed.*



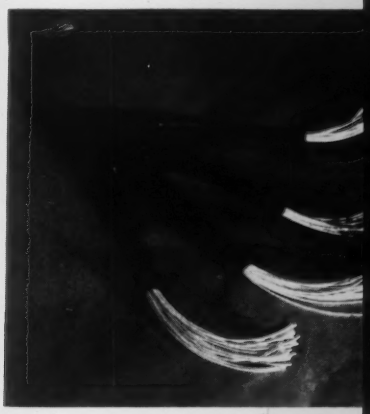
***2. Cable is painted** with a coat of urethane to protect primer from contamination and subsequent loss of adhesion.*



***3. Mold is filled** with liquid urethane. Filling from bottom forces out air and avoids air bubbles.*



***4. Mold is broken open,** and splice is removed and deflashed.*



***5. Finished splice** securely seals all areas around the cable junctions.*

Acknowledgments

The author would particularly like to thank J. P. Abbat, Director of Research and Development, Disogrin Industries, Inc.; H. H. Abernathy, E. I. du Pont de Nemours & Co., Inc.; and Dr. J. H. Saunders, Director of Research, Mobay Chemical Co. for reviewing the manuscript. The assistance of personnel and literature of the following companies is also gratefully acknowledged:

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General Tire and Rubber Co.
B. F. Goodrich Chemical Co.
Houghton Laboratories, Inc.
Maco Industries, Inc.
Mobay Chemical Co.
Thiokol Chemical Corp.

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Rugg, J. S., "Liquid Urethane Elastomers; A Status Report". Paper given at New York Rubber Group meeting, Mar '59.

Pigott, K. A., Frye, B. F., Allen, K. R., Steingiser, S., Darr, W. C., Saunders, J. H., Hardy, E. E., "The Development of Cast Urethane Elastomers for Ultimate Properties." Paper presented at meeting of Rubber Div., American Chemical Society, May '59.

U. S. Army Ballistic Missile Agency

Reentry nose cone *for Jupiter missile, shown here being lowered into special container after recovery, has antenna window made of TFE-ceramic fiber material.*

New Reinforced TFE Plastics Resist Cold Flow

by Norman L. Greenman, *Technical Director, Rogers Corp.*

They also offer chemical inertness, low ablation, low friction and good electrical properties. The secret: a highly uniform blend of resin and inorganic fiber achieved by the beater addition process.

■ The purpose of adding inorganic reinforcing fibers to TFE fluorocarbon resin is to improve resistance to cold flow and high temperature deformation under load. The first of these beater addition materials developed (see *Materials & Methods,* Nov '55, p 110) provided the desired mechanical improvement, but at a sacrifice in electrical and dry friction characteristics. More recently, other grades have been developed to overcome these drawbacks.

Five types available

At present, the five grades consist of three ceramic (aluminum silicate) fiber-reinforced types and two glass fiber-reinforced types. Properties are shown in Table 1. (Since properties of molybdenum disulfide-filled grades are similar to those of unfilled grades, with the exception of frictional characteristics, such filled grades are not listed separately.)

In general, the five materials are extremely inert chemically and resistant to temperatures as high as 500–550 F continuously and 600 F or higher intermittently. They also have excellent resistance to cold flow and deformation under load, good electrical properties, and good dry bearing characteristics. As would be expected, they are relatively expensive materials costing about $16–20 per lb.

Briefly the five types are:

1. 60:40 TFE-ceramic fiber (Duroid 5600)—Maximum resistance to cold flow; excellent chemical inertness.
2. 75:25 TFE-ceramic fiber (Duroid 5650)—Maximum chemical inertness; excellent resistance to cold flow; lowest ablation rate.
3. 60:40 TFE-ceramic fiber plus molybdenum disulfide additive (Duroid 5613)—Best combination of dry bearing characteristics and chemical inertness.
4. 85:15 TFE-glass fibers (Duroid 5870)—Best electrical characteristics.
5. 60:40 TFE-glass fibers plus molybdenum disulfide additive (Duroid 5813)—Best dry bearing characteristics (e.g., lowest coefficient of friction and most resistance to wear).

Of course, the proper grade cannot usually be selected as easily as this simplified classification might suggest. In many cases, combinations of design requirements will be somewhat contradictory (e.g., electronic windows in re-entry missile nose cones are made of one of the TFE-ceramic materials because of its ablation characteristics, although the glass-reinforced grades are better electrically).

In comparison with other fiber-reinforced TFE materials, the key to the uniqueness of these materials lies in the beater addition process, briefly described in the box on p 100. In short, the advantages of these materials lie in the uniformity of fiber distribution and the intimacy of contact between fiber and resin.

The most important limitation of beater addition materials is their lower strength as compared to fabric-reinforced fluorocarbons. Of the reinforced fluorocarbons, these materials should be used primarily where their strength is sufficient and their uniformity required.

In many uses for the materials, design requirements such as heat and chemical resistance overlap. Thus, the following classification is made on the basis of the dominant design requirement.

Chemical resistance

Gasketing and sealing of all types of corrosive materials at both high and low temperatures are one of the earliest and most

important uses for these materials. Ceramic fiber-reinforced grades are usually used for such applications because the ceramic is more inert chemically than the glass.

Static seals—For static gaskets and seals, the 60:40 TFE-ceramic material provides maximum resistance to cold flow and extrusion. The cold flow in unreinforced TFE fluorocarbon resin can result in stress relaxation and a loosening of the seal. The curves in Fig 1 show that stress relaxation in the ceramic fiber-reinforced material at 300 F reaches a maximum after about 10 hr and afterward is no longer a factor.

The 60:40 TFE-ceramic material has a specific gravity of 1.90 and can be compressed nearly 20% (14% at 5000 psi by ASTM D 1170) in a gasket application. Reinforced materials do have somewhat greater permeability to mobile fluids than does pure TFE. However, in flat gasket applications, the fluid must travel through the width of the gasket seal; thus the seal provides the effect of a thick section.

The 75:25 TFE-ceramic fiber grade has a specific gravity of 2.15 and compressibility of 7% at 5000 psi. Generally its properties are intermediate between those of TFE and the 60:40 grade. Because of its higher resin content it is less permeable than the 60:40 grade.

In general, loadings required to seal reinforced TFE gaskets are similar to those required for compressed asbestos gaskets. The 75:25 material requires somewhat higher loadings than the 60:40 grade.

Some proven sealing applications are valve seats and seals, flange gaskets, oil ring seals (operating intermittently at 650 F), kettle and reactor seals, process control instrument gaskets, and heat exchanger gaskets.

The materials have been used satisfactorily in 70% hydrofluoric acid and anhydrous hydrogen fluoride (no effect after 48 hr), and sulfuric acid continuously at 400 F. They have been used as ring gaskets in nitric acid mixtures at 500 F and 400 psi pressure, as centrifuge packings in sodium hydroxide at 1000 psi pressure and as filter seals for liquid oxygen at –300 F and 30 psi pressure. (Impact sensitivity tests on reinforced materials after immersion in liquid oxygen at –320 F indicate about the same high order of resistance to shock loading as unreinforced TFE fluorocarbon, CFE fluorocarbon, white asbestos packing, and Electrofilm Coating No. 4396.)

Dynamic seals—Dynamic seal-

TABLE 1—PROPERTIES OF REINFORCED TFE FLUOROCARBON RESIN

Type →		Virgin TFE[a]	Ceramic Fiber-Reinforced		Glass Fiber-Reinforced (85:15 TFE-Fiber[b])
			60:40 TFE-Fiber[a]	75:25 TFE-Fiber	
MECHANICAL PROPERTIES	ASTM				
Ten Str, 1000 psi					
Mach Dir	D638	1.5-3.0	2.6	4.5	7-8
Cross Mach Dir	D638	1.5-3.0	1.8	3.0	4-6
Stiffness, 1000 psi					
Mach Dir	D747	50-90	140	>160	>120
Cross Mach Dir	D747	50-90	115	>160	>120
Compressibility (5000 psi), %	D1170	—	14	7	6
Impact Str (Izod), ft-lb/in. notch					
Edge	D256	3	1.10	1.25	—
Face	D256	3	1.50	1.75	—
Hardness (Shore)		D50-65	D66	D72	D73
Coef of Friction (4000 psi load)					
Static		0.032[c]	0.060	0.048, 0.043[d]	0.028, 0.022[d]
Dynamic (2 sfm)		0.018	0.050	0.045, 0.040[d]	0.025, 0.018[d]
Def under Load (122 F), %					
1200 Psi	D621	4-8	2	0.2	0.2
2000 Psi	D621	>25	3	0.8	0.6
Def under Load (300 F), %					
1200 Psi	D621	4	1	1	0.4
2000 Psi	D621	25	2	3	1.0
PHYSICAL PROPERTIES					
Specific Gravity	D792	2.1-2.2	1.90	2.15	2.15
Specific Heat, Btu/lb/°F		0.25	0.23	0.24	0.22
Ther Exp Coef (73-140 F), 10^{-5}/°F	D696	5.5	1.6, 2.0[e]	1.9, 2.2[e]	1.6, 5.0[e]
Ther Cond, Btu/hr/sq ft/°F/in.	Cenco Finch	1.7	2.22	1.89	2.1
Heat Distortion Temp, F					
66 Psi	D648	250	500+	400	500+
264 Psi	D648	—	500+	250	500+
Water Absorp (24 hr, 70 F), %					
Sheet		0.005	3.0	1	0.25
Molded		0.005	0.0	0	0
ELECTRICAL PROPERTIES					
Dielec Str (short time), v/mil	D149	400-500	150	250	300
Dielec Const					
60 Cps	D150	2.00	2.7	2.5	—
10^6 Cps	D150	2.00	2.5	2.4	2.4
Power Factor					
60 Cps	D150	0.0003	0.03	0.0023	—
10^6 Cps	D150	0.0003	0.003	0.0012	0.0005
Surface Res, ohms	D257				
As Received		3.6×10^{12}	1.4×10^{13}	$>1.1 \times 10^{16}$	3×10^{14}[f]
96 Hr, 100% RH		3.6×10^{12}	4.2×10^{5}	3.4×10^{7}	3×10^{14}[f]
Arc Resistance, sec	D495	No track	195	195	195
Volume Res, ohm-cm					
As Received	D257	$>10^{15}$	4.6×10^{11}	1.7×10^{16}	—
96 Hr, 100% RH	D257	$>10^{15}$	1.6×10^{7}	1.8×10^{8}	—

[a]Source: E. I. du Pont de Nemours, except values for deformation under load at 300 F.
[b]With the exception of frictional values, properties of MoS_2-filled grades are very similar to those of unfilled grades.
[c]Teflon 7X. [d]Second values are for MoS_2-filled grades.
[e]Longitudinal and transverse, respectively. [f]Values obtained on etched copper-clad sheets.

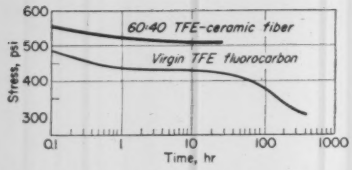


Fig 1—*Note that stress-relaxation of the reinforced TFE fluorocarbon levels out at the 10-hr level in this test at 300 F on an unconfined gasket 1/16 in. thick.*
(E. I. du Pont de Nemours & Co., Inc.)

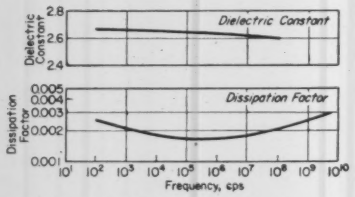


Fig 2—*Effect of frequency on dissipation factor and dielectric constant of 75:25 TFE-ceramic fiber material.*

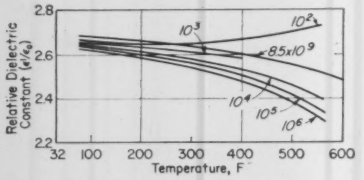


Fig 3—*Effect of temperature on dielectric constant of 75:25 TFE-ceramic fiber material at various frequencies.*

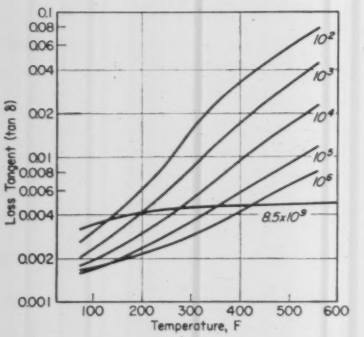


Fig 4—*Effect of temperature on loss tangent of 75:25 TFE-ceramic fiber material at various frequencies.*

ing conditions, particularly in aircraft design, have become extremely critical. Operating temperatures above 500 F and corrosive conditions such as immersion in MIL-L-7808 hydraulic fluids have caused serious problems in backup ring materials.

The TFE-ceramic-MoS_2 material provides the required stability under the severe operating conditions, yet provides self-lubrication and wear resistance qualities superior to those of unfilled types.

Friction data obtained under high load conditions are shown in Table 1. Although frictional data developed from standard tests do not indicate substantial differences among the five grades, considerable improvement in operation of the MoS_2-filled material is encountered in actual service, when loads and temperatures are increased. The filled grade has about ten times better wear resistance than the unfilled.

In long-stroke backup ring applications, such as in actuators, pumps and afterburner controls, the material has been used to back up fluoroelastomer o-rings in MIL-L-7808 hydraulic fluids at temperatures up to 550 F and pressures of 3000 psi. In this type of application backup rings have withstood up to 500,000 cycles of 4-in. stroke operation without failure.

The material is also recommended for short-stroke high frequency use, such as is encountered in servomechanisms operating with a ¼-in. stroke at 6 cps under 450 F and 3000 psi continuous pressure.

Electrical transparency and insulation

TFE fluorocarbon is both an excellent electrical insulating material and "transparent" to high frequency radio waves. As shown in Table 1, ceramic fiber reinforcement impairs dielectric char-

Beater Addition: Old Process, New Use

The beater process used by Rogers Corp. makes use of beaters similar to those used in fluffing the pulp fibers in paper production.

The TFE fluorocarbon resin, in a water dispersion, is added to a dilute suspension of ceramic or glass fibers in water. The mixture then passes through the beaters and is formed into sheet on a modified cylinder-type paper machine.

Because the process is carried out in an extremely dilute suspension, the result is a highly homogeneous blend of fiber and resin in which each fiber is actually encapsulated by resin. The resin particle size in the dispersion is 1μ or less; thus the resin becomes a part of the dispersing medium for the fibers, and coats each individual fiber with resin. Best results are obtained when the particle size of the resin is substantially less than the diameter of the fiber.

The cylinder-type wet machine on which the moldable sheet is formed is actually a wet laminating device. Very thin, uniform plies of fiber and resin are continually being wound on the cylinder, and the sheet is removed when the desired thickness is reached. Thus, a molded sheet 1/16 in. thick may consist of 40 to 60 laminations, uniform in themselves, and bonded together while wet on the cylinder. Uniformity is essentially the same as that obtained in high quality electrical insulating papers, produced by this method for over 50 years.

TABLE 2—DIRECTIONAL THERMAL EXPANSION OF REINFORCED TFE•
(Coefficients Given As 10^{-6}/°F)

Temp Range, F ➡	−40 to 30	30 to 60	60 to 75	75 to 90	90 to 120	120 to 170	170 to 200
Perp to Lam.....	69.9	90.9	422.7	124.5	101.2	125.8	156.1
Mach Dir.....	10.0	10.2	90	9.9	7.2	5.1	3.6
Cross Mach Dir....	18.6	21.8	32.3	28.1	16.4	10.7	5.8

•75:25 TFE-ceramic fiber laminated slabs.
Source: Goodyear Aircraft Corp.

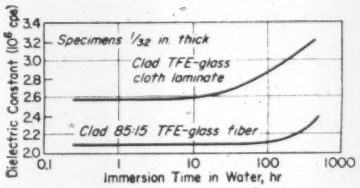


***Fig 5**—Effects of water immersion on dielectric constant: copper-clad 85:15 TFE-glass fiber vs copper-clad TFE-glass cloth laminate.*

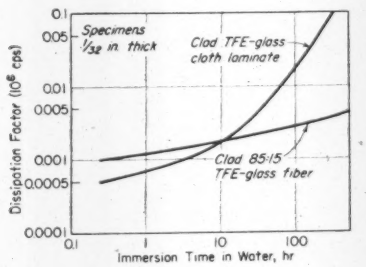


***Fig 6**—Effects of water immersion on dissipation factor: copper-clad 85:15 TFE-glass fiber vs copper-clad TFE-glass cloth laminate.*

acteristics by reducing dielectric strength and resistivity, and increasing dielectric constant and loss (as shown by power factor).

The glass fiber-reinforced TFE has substantially improved electrical characteristics, though values are naturally not as good as those of unfilled TFE. Glass-reinforced grades provide a strong, dimensionally stable, high temperature dielectric particularly well suited for high frequency applications.

The major electrical and electronic applications for both ceramic and glass fiber-reinforced TFE are 1) antenna wave guide inserts for missile nose cones and 2) printed circuit base stock. Other potential electrical and electronic applications include microwave plumbing, stand-off insulation, circuit breaker bearings, slot liners and phase separators.

Re-entry and ablation—For antenna wave guide inserts in re-entry cones of IRBM and ICBM missiles, one of the TFE-ceramic fiber materials is most widely used. Although dielectric properties are not as good as those of the glass fiber-reinforced grades, ablation characteristics are better, and microwave transparency is excellent. Also, during ablation the surface does not carbonize; thus signals remain undistorted.

The material's voltage standing wave ratio is under 1.8. Dielectric constant is essentially unchanged over a temperature range of 77 to 575 F and frequency range of 10^2 to 10^{10} cps. Dissipation factor at 10^{10} cps is almost independent of temperature.

In addition to dielectric qualities, the ceramic fiber-reinforced TFE material has an even, consistent ablation rate which seems to be comparable to that of the reinforced phenolic or phenyl silane resins used in ablation-type re-entry cones.

In heavy laminated slabs used for antenna windows approximately 60% of the fibers are oriented in the machine direction, 40% in the cross-machine direction. Ablation rates depend to a great extent on the orientation of the fibers with respect to gas flow. In tests on these slabs, lower ablation rates have been obtained by exposing end or edge grains so that direction of gas flow is perpendicular to fiber orientation.

In designing an assembly with a part as large as an antenna window, the directional thermal expansion characteristics of the material become critical. Table 2 shows thermal expansion coefficients for 75:25 TFE-ceramic material in three directions and over seven temperature ranges.

Printed circuit base stock—Both the 75:25 TFE-ceramic fiber and the newer 85:15 TFE-glass fiber materials have been successfully used to form a dimensionally stable high temperature base for printed circuits. A minimum bond strength between copper foil and sheet of 6 to 8 lb is obtainable; average bond strength is about 15 lb.

Fig 2 shows the effect of frequency, and Fig 3 and 4 of temperature, on dielectric constant and dissipation factor of the 75:25 TFE-ceramic material.

Fewer data are available on the more recent glass fiber-reinforced materials. In comparison with the ceramic-reinforced grades, they have higher dielectric strength and resistivity, and lower dielectric constant and power factor. Fig 5 and 6 show the effect of immersion in water on dielectric constant and dissipation factor of a copper-clad 85:15 TFE-glass fiber material, as compared to a glass cloth-reinforced TFE material.

Low friction

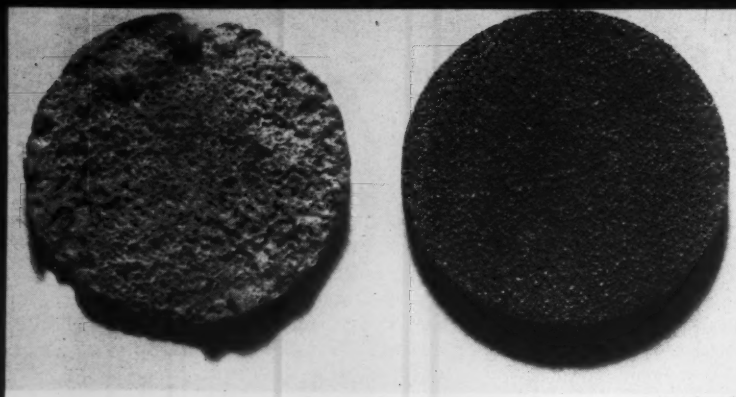
The glass-reinforced TFE material containing molybdenum disulfide filler has the best frictional characteristics of all the reinforced TFE materials shown in Table 1. Although the MoS_2-filled, ceramic fiber-reinforced material is used for low friction applications where a high degree of chemical stability is required, such as in hydraulic backup rings, the glass-reinforced material is superior for dry bearing use where maximum chemical resistance is not required.

This material is particularly useful for sleeve or thrust washer bearings designed to operate at both low and high ambient temperatures (–320 to 550 F), involving high unit loading and low surface speeds. The material is also recommended for slides, guides and cams.

An average PV factor of 10,000 should be used; higher values are permissible at lower surface speeds. Because of the low thermal conductivity of the material, speeds should generally not exceed 200 sfpm, though this figure may be increased if good cooling conditions are provided.

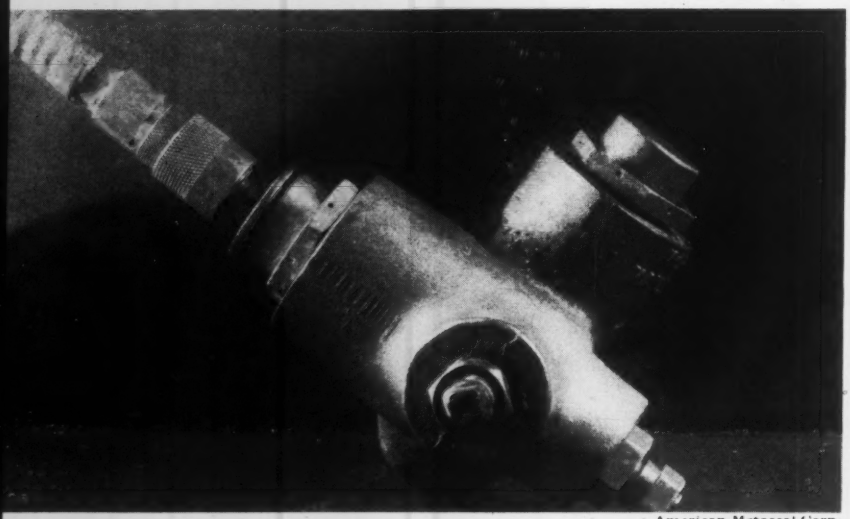
The low thermal expansion characteristics of the material permit relatively small radial clearances; 0.003 to 0.005 in. for diameters up to 1 in. have been satisfactory. Where high frictional heat is anticipated, clearances should be pretested. If bearings are to operate in ambient temperatures over 400 F, the material should be normalized by heating to the use temperature before machining the bearing.

Mating surfaces should have a fine finish. Generally, the harder the mating surface, the better the performance. Mating surface hardnesses of Rockwell C50 have provided excellent bearing service.



American Metaseal Corp.

Chemical resistance *provided by polyester-styrene impregnant is shown in this photograph of an impregnated bronze disk before and after immersion in nitric acid. Bronze in immersed disk (left) has completely dissolved, leaving the untouched impregnant intact.*



American Metaseal Corp.

Gas leakage, *shown in this underwater photograph of an internally pressurized bronze casting, can be prevented by impregnating the casting.*

Impregnants for Castings

Impregnation is an inexpensive way to make castings pressure-tight and improve their corrosion resistance. This article tells what types of impregnants are available and what they can do.

by Robert J. Fabian, *Associate Editor, Materials in Design Engineering*

■ A certain amount of porosity can be expected in most metal castings. In most applications this inherent porosity does not significantly affect performance. However, in applications where pressure tightness and high corrosion resistance are needed, casting porosity is a critical design factor and steps must be taken to eliminate its effects.

The amount of porosity in castings can be reduced considerably by careful design and suitable foundry techniques, such as careful degasification of the liquid metal and proper location of gates and risers. However, these measures are only partially remedial and cannot completely prevent the formation of pores which interconnect the interior and exterior surfaces of the casting. The most effective way to nullify the detrimental effects of these pores is to fill them with an impregnant.

Depending on the size and type of casting, a casting impregnant can be applied by high pressure, by high vacuum, or by a combined vacuum and pressure treatment (see box, p 104). All of these treatments force the impregnant into the innermost portions of the casting where it fills up the pores and fills or blocks off interconnecting passages.

The two most successful impregnants available are the polyester types and sodium silicate. In general, the polyester types are more durable and more effective than sodium silicate; however, they are also more expensive. Very roughly, the cost of impregnating small aluminum die castings in large volumes with a typical polyester-styrene impregnant can range from 15 to 20¢ per lb. The cost of impregnating the same castings with sodium silicate can range from 10 to 15¢ per lb. Naturally, costs can vary widely depending on the volume of castings processed, complexity of the castings, and the impregnating equipment available.

What does an impregnant do?

Usually the most important job is to prevent leakage. But it can also help stop corrosion and keep surface coatings sound and attractive.

Prevents leakage of pressurized fluids

The most important effect of impregnation is to make the casting pressure-tight and prevent any leakage of pressurized liquids or gases through the body of the casting during use. In many cases a properly impregnated casting can be hydraulically tested to destruction without any leakage occuring because of porosity. Aluminum and magnesium castings impregnated with a polyester-type impregnant have successfully withstood such tests. In fact, a properly impregnated porous area will withstand as much pressure as an area containing little porosity.

Prevents corrosion

In many cases a highly porous casting can have high internal corrosion without any damage showing on the surface. This is particularly true if foreign materials are lodged in the pores of the casting in the presence of an electrolyte. Electrolytic corrosion of this type, as well as chemical corrosion, can be prevented by using an impregnant which completely fills the casting pores and prevents the entry of any corrosive materials.

Improves surface coatings

The quality and performance of a number of different surface coatings can be improved by impregnating castings prior to applying the coatings.

Electroplated coatings—Porous areas in castings have a tendency to retain cleaning and plating solutions. These solutions can leak out of the pores after plating and corrode and mar the appearance of the electroplate.

Organic coatings — In many cases blistering of a paint during baking is caused by the expansion and escape of entrapped air in the casting when it is heated.

Anodized finishes—In the case of aluminum castings, anodizing solutions entrapped in pores can give off gases which form small bubbles on the surface of the casting. These bubbles can electrically insulate surface areas and prevent them from being anodized This condition can be prevented by impregnating the casting before anodizing and dyeing. The casting can also be impregnated after anodizing to close up any pores which may have been opened up by the anodizing solution.

Polyester impregnants

are widely used for critical applications because of their 100% solids content, resulting in low shrinkage after curing, and their resistance to a wide range of corrosive media.

Types available

Most polyester impregnants available today consist of a polyester resin which is copolymerized with styrene, diallyl phthalate or vinyl toluene. Of these copolymers, the polyester-styrene and the polyester-diallyl phthalate impregnants are the most popular.

In general, there is not much variation in the composition of polyester-diallyl phthalate impregnants. However, the percentage of styrene used in polyester-styrene impregnants can vary over a wide range. Some polyester-styrene impregnants are supplied as a two-package system in which the styrene is added at the time of use in varying amounts up to about 60%. However, most polyester-styrene impregnants are supplied ready to use. The styrene content of these ready-to-use impregnants is usually about 25 to 30%, but it can be made as high as 50% if lower viscosity is needed.

Properties

Although they cost more than sodium silicate impregnants, polyester impregnants have a much wider range of properties. Properly formulated polyester-type impregnants can be used with every type of metal. Another distinguishing property is their 100% solids content. Since the impregnants do not contain any solvents, little shrinkage occurs during curing. The hardened impregnant completely fills the pores, making them resistant to pressures as high as 15,000 psi. In addition, because of their low viscosity and surface tension, polyester-type impregnants have excellent penetration and fill highly microporous areas in one impregnation cycle.

Polyester-type impregnants are fungus-proof, have excellent resistance to water and steam, and have good resistance to gasoline and other fuels, oils, alcohols, solvents, glycols, salts, mild acids, and most food products. Polyester-styrene impregnants have been reported to have better resistance to jet fuels, oils and dichromate solutions than polyester-diallyl phthalate impregnants; however, the advantage does not appear to be too significant. In any event, some trial tests under actual service conditions should be made with the various types of impregnants before final selection is made.

Polyester-type impregnants have a fairly wide temperature range. They can be used at a constant operating temperature as low as —65 F, and intermittently at —75 to —80 F. Depending on the composition used, maximum constant operating temperature varies from 300 to 350 F, and maximum intermittent temperature from 400 to 500 F. Because of their resiliency the impregnants do not tend to rupture when rapid temperature changes produce dimensional changes in the metal.

One special precaution should be observed when using polyester-styrene impregnants. Some impregnating solutions containing styrene will not cure properly if they are allowed to come in contact with copper or copper-base alloys such as brass and bronze. With all copper-base castings it is necessary to use a polyester-styrene impregnant containing special stabilizers that promote curing. Many of the polyester-styrene impregnants available today contain

such stabilizers and can be used on all types of iron, aluminum and magnesium castings, as well as all copper-bearing castings.

Application procedures

In general, the same basic application steps are followed with the various types of polyester impregnants. Any differences that exist are likely to be found in the cleaning and curing stages. Following is a typical sequence of operations.

1. Preparation of castings. Naturally, all castings should be cleansed of any contaminants which might prevent proper impregnation. Occasionally, it may also be necessary to heat the castings at about 250 F to evaporate entrapped moisture.

2. Impregnation. The various pressure treatments available for impregnation are described in the accompanying box. In contrast to the sodium silicate impregnants which can be kept at any temperature, polyester-type impregnants must be maintained at a temperature of about 68 to 70 F. Polyester-diallyl phthalate impregnants have a tendency to gel at room temperature and must be aerated with dry air to maintain viscosity. In the case of the polyester-styrene impregnants, viscosity can be maintained by adding more styrene.

3. Cleaning. After impregnating with a diallyl phthalate impregnant it is usually necessary to clean off the surplus impregnant in a vapor degreaser. Polyester-styrene impregnants, however, are usually cleaned off with a mild detergent or a solvent cleaner.

4. Curing. Ordinarily, a polyester-diallyl phthalate impregnant is cured in an oven for 3 to 5 hr at 257 to 275 F. Similarly, some types of polyester-styrene impregnants can be cured at 275 F for 1½ to 5 hr. In some cases, contact curing in a mineral oil for 75 min at 265 F can be substituted for oven curing. Contact, or immersion, curing is claimed to be advantageous in that it prevents impregnant bleedout, promotes even heat distribution, and simplifies post-cleaning operations.

5. Post-cleaning. Generally the same as step *3*.

Uses

In contrast to sodium silicate impregnants, suitably formulated polyester impregnants can be successfully used for almost every kind of casting and application. One of the largest uses of the impregnants is internal combustion engines, where they are used in castings for cylinder heads, car-

How Impregnants Are Applied

Wide differences exist in the cleaning and curing procedures recommended for each impregnating material. However, the actual impregnating procedures used for all impregnants are more or less the same. Choice of the best procedure usually depends on the size of the casting and the quantity that must be processed. Following is a description of the commonly used impregnating procedures.

Batch Impregnation

Batch impregnation is the most popular impregnation method in use and is best suited for processing small castings in large quantities. Castings are placed in a large autoclave and a vacuum of about 28 in. Hg is created. This vacuum exists in all pores of the casting which interconnect to the surface. The vacuum is held for about 15 to 30 min to allow enough time to remove all gases. A heated vacuum tank is desirable—although not required—to promote removal of gases and moisture. At the end of the prescribed time enough impregnant is drawn into the autoclave to cover the parts. The impregnant is kept under vacuum for a predetermined time (3 to 5 min for polyester-type impregnants), after which the vacuum is removed. A positive pressure of about 90 to 100 psig is then applied and held for about 30 min.

An important advantage of this method is that it does not produce differential pressure stresses in the casting. That is, at any given autoclave pressure, the pressures inside and outside the casting are equal.

Internal pressure

The internal pressure method is best suited for impregnating large castings and does not require an autoclave. All openings in the casting are blocked (except the impregnant entry port) and the impregnant is introduced at a pressure of about 250 psi. Since there is a 250-psi pressure difference between the inside and outside of the casting it should first be determined if the casting is strong enough to withstand the pressure differential. This method also provides a method of inspection, as the areas that leak or are excessively porous can be observed as the liquid is forced through. Although the method provides good impregnation, it is not believed to be as efficient as the vacuum method which removes entrapped gases.

External pressure

This method is also best suited for impregnating large castings. All openings in the casting are sealed except for one port which is connected to a vacuum pump. The casting is then immersed in the impregnant and a vacuum drawn inside the casting. This vacuum tends to suck the impregnant through the casting from the outside to the inside. Since the maximum vacuum that can be created inside the casting is about 28 in. Hg, a comparatively small pressure differential exists. Thus, the method is slow and somewhat inefficient.

Immersion

Immersion is an easy but not very effective method that is sometimes used with polyester-styrene impregnants. The castings are warmed and then placed in an open tank of cold impregnant. The warm surfaces of the castings tend to lower the viscosity of the impregnant and promote penetration. However, complete impregnation cannot be obtained with this method and it is not recommended for critical applications.

buretors, air conditioner compressors, water pumps, oil pump housings, supercharger housings and crankcase housings. The impregnants are widely used in castings for gas and steam fittings, meters, valves, water and fuel pumps, turbines, plumbing fixtures, refrigerator assemblies and steam plant equipment. They are also used in electronic waveguides and radar equipment.

Sodium silicate impregnants

are comparatively inexpensive and can provide effective resistance against pressure leakage and corrosion in many noncritical ferrous and aluminum castings.

Types available

One of the principal types of sodium silicate impregnants in use consists of a dispersion of extremely small droplets of sodium silicate in water. The water acts as a carrier for the sodium silicate, and after the silicate has been impregnated the water is evaporated off. The sodium silicate left behind tends to fill the pores in the casting and block them off. However, since up to 50% of the impregnant (the water) is evaporated, 100% solids content cannot be obtained. Actually, the water in the impregnant tends to corrode shut some of the pores in ferrous castings, but the benefit of this kind of sealing action is questionable for critical applications. If necessary, an oxidizing agent can be added to the sodium silicate suspension to promote corrosion and further sealing in ferrous castings.

Another type of sodium silicate impregnant that is widely used consists of a water solution of sodium silicate and an oxidizing agent, together with a high content of metallic and nonmetallic particles. These particles may consist of various combinations of pure copper and iron colloids, metal oxides, graphitic carbon, ground asbestos and siliceous earth. The purpose of these particles is to block off pores and passages in the casting.

Properties

Sodium silicate impregnants are primarily intended for pressure sealing applications. Although they are not as effective as polyester-type impregnants, some types of sodium silicate impregnants are claimed to be useful up to 10,000 psi.

Sodium silicate impregnants are not recommended for improving the corrosion resistance of castings, or for improving the quality of subsequent electroplates. The corrosive agents present in sodium silicate impregnants can produce corrosive products which exude to the surface and cause trouble. Because of their corrosive action, sodium silicate impregnants are not recommended for magnesium and copper-base castings. They are

American Metaseal Corp.

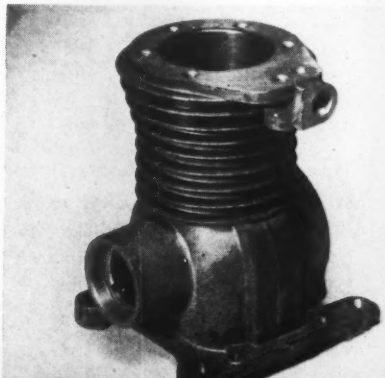
*Left—**Aluminum aircraft part.** Impregnant: polyester-styrene. Top—**Aluminum fuel system fitting.** Impregnant: polyester-styrene. Bottom—**Bronze waveguide flange.** Impregnant: polyester-styrene.*

F. J. Stokes Corp.; Canadian Acme Screw & Gear

***Magnesium gearbox housing** for jet engine. Impregnant: polyester-diallyl phthalate.*

***Aluminum cylinder** used in automobile air conditioner. Impregnant: polyester-styrene.*

Impco, Inc.



***Aluminum tank** used to hold solvent cleaners. Impregnant: sodium silicate.*

American Metaseal Corp.

primarily used with ferrous castings, and occasionally with aluminum and zinc castings where low-cost pressure sealing is needed.

Application procedures

In general, sodium silicate impregnants are somewhat easier to apply than polyester-type impregnants. The initial pretreatment and impregnation steps for the two impregnants are about the same. However, the post-treatment and curing operations required with sodium silicate impregnants are comparatively simple. In some cases, silicate impregnants do not have to be heat cured, and the water is allowed to evaporate at room temperature. If fast production is needed the water can be quickly evaporated in an oven. However, temperature should be kept below 212 F to prevent boiling of the water within the casting which could rupture the sodium silicate deposits.

Uses

Because of their less-than-optimum sealing action and their inability to provide good corrosion resistance, sodium silicate impregnants are not recommeded for military applications. However, their low cost is an advantage in such commercial applications as automotive cylinder blocks, battery cases, transmission housings, household garbage disposal parts, plumbing fixtures and chemical processing fittings.

Metal powder impregnants,

although still in the development stage, appear to have good potential for high temperature applications.

Composition

A basic metal powder impregnant consists of a combination of 80 zinc, 10 copper and 10% aluminum powders (melting point: 720 F). For best sealing, a concentration of 78.5% powder solids is mixed with isobutyl alcohol. Flammability of the alcohol can be a drawback; however, less flammable vehicles such as water with corrosion inhibitors can be used.

Properties

The most important property of metal powder impregnants is their ability to make castings pressure-tight at high temperatures. Impregnated castings remain air-tight at temperatures of 100 F and higher—as high as 1650 F in one instance. Tests made with highly porous (25%) iron powder parts showed an air leakage rate of 570 cu in./sq in./sec under a pressure drop of 25 psi. After impregnation, leakage was reduced to 1.2 cu in./sq in./sec. The leakage rate for water was less than 0.000007 cu in./sq in./sec. The sealing action provided by metal powder impregnants can be maintained in the presence of oil, water and steam.

Application procedures

The pretreatment and impregnating steps used with metal powder impregnants are generally the same as those used with conventional impregnants. However, after impregnation the castings are removed and fired at 1300 F for 40 min. This high temperature produces a "microbrazing" action in the metal powders, causing them to melt and run into the narrowest pores by capillary action. Thus, a very effective seal is formed after solidification.

Uses

The metal powder impregnants were developed only recently and because of their newness have not yet been used in any significant application. However, results of tests performed on commercial castings indicate that these impregnants can be used to completely seal typical ferrous and nonferrous castings.

Other impregnants

are available. Once extremely popular, they are not widely used today, because of the development of better materials.

In addition to the impregnants already described, a number of other casting impregnants are available. At one time some of these impregnants were extremely popular, mainly because they were the only materials that were available. However, with the development of newer and better materials, they are now used only in comparatively small quantities.

Phenolic impregnants were used in very large quantities during World War II and are still used today, although to a minor degree. A phenolic resin that is properly impregnated and baked will withstand pressures of 500 to 800 psi. Phenolic impregnants are resistant to water, solvents, mild acids and alkalis, and are permanent under normal conditions.

Phenolic impregnants are generally used in the as-received condition, since they are sufficiently thin to penetrate quite thoroughly. If casting porosity is very minute and high pressures are to be encountered, better results are sometimes obtained by diluting the resin with 10% water or 10% denatured alcohol. Application procedures are generally the same as with conventional impregnants.

Sal ammonica is a rust-producing impregnant which has largely passed into disuse. It is occasionally used today on large ferrous castings that rust easily and are subject to low static pressures.

Tung oil impregnants are used to a very limited extent today. Penetration of these impregnants can be improved by adding benzene derivatives.

Styrene monomer can be reacted with linseed oil or dehydrated castor oil to produce impregnants with moderate pressure-sealing properties. However, these impregnants have never become too popular because of the tendency of the styrene to evaporate rapidly during gelling.

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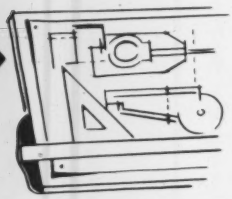

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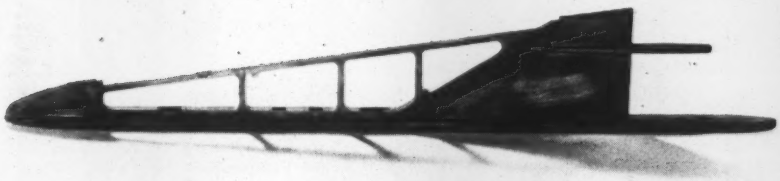

Doehler-Jarvis Div., National Lead Co.

Magnesium *fin for guided missile has high strength-to-weight ratio.*

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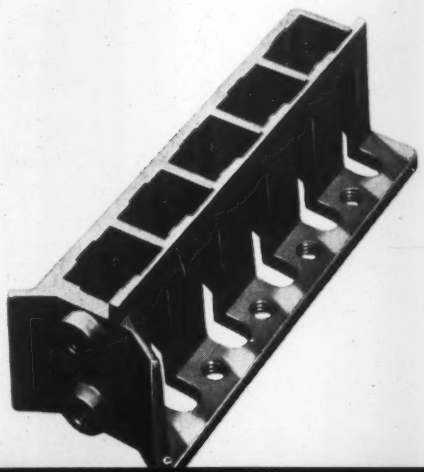
Brass *brush holder for welding generator has high strength.*

Titan Metal Mfg. Co.



- *Why use die castings . . . advantages . . . limitations . . . comparisons*
- *What alloy to use . . . properties . . . cost . . . producibility . . . other factors*
- *Designing die castings . . . sections . . . tolerances . . . bosses . . . other features*

by Robert J. Fabian, *Associate Editor*
Materials in Design Engineering

Choosing the alloy: consider these factors

Die casting is limited to those metals which are compatible with die steels, namely: zinc, aluminum, magnesium, copper, lead and tin. These alloys have a wide range of properties and cost and many factors have to be considered in selecting the best alloy for a specific application. Briefly, here is how the alloys compare:

Cost

Cost is a primary factor in selecting an alloy for decorative applications and is usually a secondary factor in functional applications where a specific property, such as corrosion resistance, is needed regardless of cost. In addition to the basic cost of the alloy, the final cost of a die casting involves many other factors such as die cost, production cost, and machining and finishing costs, all of which vary with the alloy used.

In general, the relative costs of die castings rate as follows (from lowest to highest): 1) zinc, 2) aluminum and magnesium and 3) copper. Actually, under some market conditions there may not be much difference in the price of zinc and aluminum or magnesium die castings. In many cases die castings can be designed so that they can be made of either zinc, aluminum or magnesium, depending on which metal happens to be cheaper at a particular time.

Mechanical properties

A comparison of the four principal die casting alloys shows that the copper-base (brass) alloys have the highest tensile strength, ranging from 45,000 to 90,000 psi. Next in order of tensile strength are the zinc alloys with a tensile strength of 41,000 to 47,000 psi, and the aluminum alloys with a tensile strength of 33,000 to 48,000 psi. Magnesium alloys have a tensile strength of 32,000 to 36,000 psi.

Brass die castings also have the highest impact strength and hardness of the die casting alloys. Next best in impact strength and hardness are the zinc alloys. Following zinc are the aluminum and magnesium alloys which are roughly equal in impact resistance and hardness.

The above data are not meant to imply that brass is the most suitable alloy for all structural die castings. Actually, brass is used in fewer structural applications than zinc, aluminum or magnesium because of its comparatively high cost and poorer producibility.

Weight

Magnesium, of course, has the lowest density of the die casting alloys —0.066 lb per cu in. Next in order of increasing density are aluminum, 0.096; zinc, 0.24; and brass, 0.297. Because of its low density magnesium is an obvious choice for many lightweight structural applications.

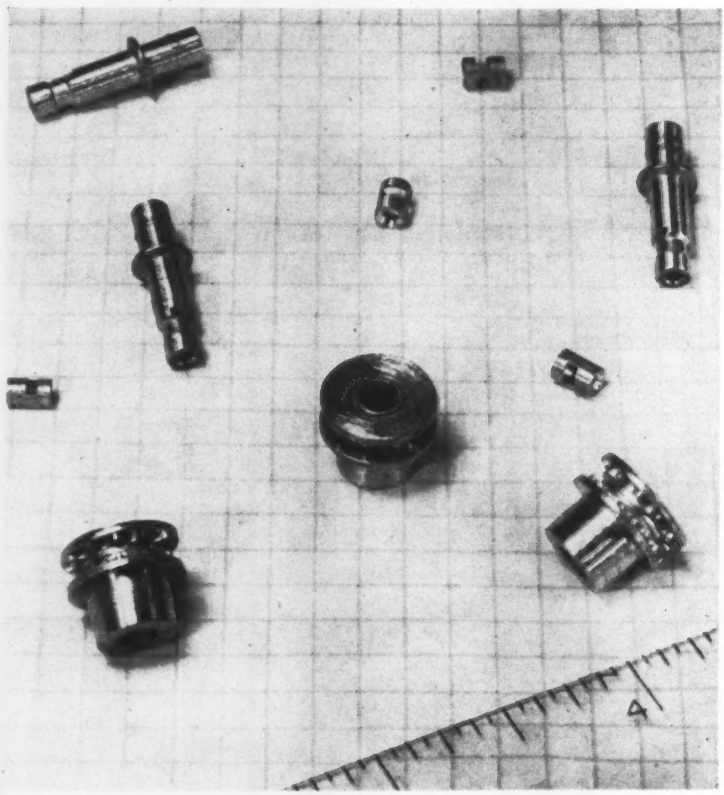
Appearance

No matter what alloy is used, all die castings have to be given some kind of surface treatment to improve their appearance for decorative applications.

Aside from brass die castings which are not ordinarily used for decorative uses, all of the alloys can be readily finished in a variety of decorative organic coatings. Zinc die castings are more easily chromium electroplated than the other alloys and thus are widely used in automobiles and appliances. Unlike zinc, aluminum die castings can be given a highly polished finish or an anodic coating which does not deteriorate in service. Most magnesium die castings are provided with an organic coating or chemical conversion coating for decorative applications.

Corrosion resistance

It is difficult to compare the corrosion resistance of the various alloys. However, if no surface treatment is used (admittedly an unlikely situation) then the alloys can be roughly rated as follows: brass, alu-



Gries Reproducer Corp.

Small zinc die castings *are machined as an integral part of casting cycle. New production method enables chamfering, counterboring, peening, tapping, threading and other operations to be performed directly on the die casting machine without re-orienting the part.*

minum, zinc and magnesium.

Even though a particular die casting alloy may have poor corrosion resistance, this property can be considerably improved by using a suitable protective coating. For example, zinc normally has poorer corrosion resistance than aluminum, but a chromium-electroplated zinc die casting resists corrosion just as well as an unfinished aluminum part in automotive applications. Naturally, every corrosion environment is unique and the engineer should experiment with the various alloys either in actual service or under simulated service conditions.

Accuracy and complexity

Because of the ease with which it can be cast, zinc provides the highest accuracy, closest dimensional tolerances, and greatest complexity of design in die castings. Aluminum and magnesium die castings offer about equal accuracy and complexity of design and they rate slightly behind zinc. Because of their greater shrinkage, brass die castings are less accurate and must be less complex than other alloy die castings.

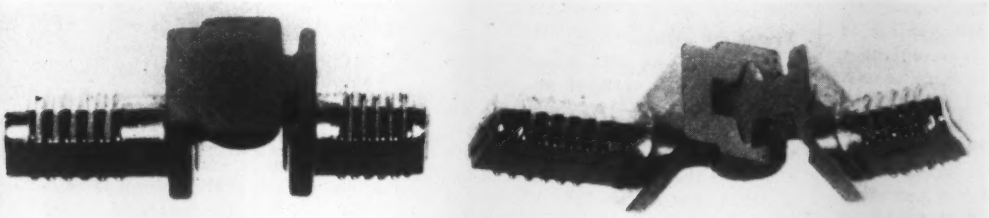
Resistance to high temperatures

Die castings are only occasionally used at high temperatures. In such applications it becomes evident that the resistance of the four principal alloys is roughly related to their melting point. Thus, in order of decreasing high temperature resistance the alloys rate as follows: 1) brass, 2) aluminum and magnesium, and 3) zinc.

The temperature at which brass die castings exhibit marginal structural strength is roughly 500 F. Conventional aluminum and magnesium die casting alloys have similar melting points. Aluminum is suitable up to 500 F and magnesium is suitable up to 350 F in structural applications. (However, a new magnesium-thorium alloy (Dow HM11XA) is claimed to retain good mechanical properties up to 800 F.) The maximum usable temperature of zinc alloy castings is about 210 F.

Castability

Castability refers to the ease and speed of producing die castings. Because of its excellent fluidity, zinc is the easiest metal to die cast, and it permits very high production rates. Next in order of castability are magnesium, aluminum and brass. Brass has considerably poorer castability than the other die casting alloys.



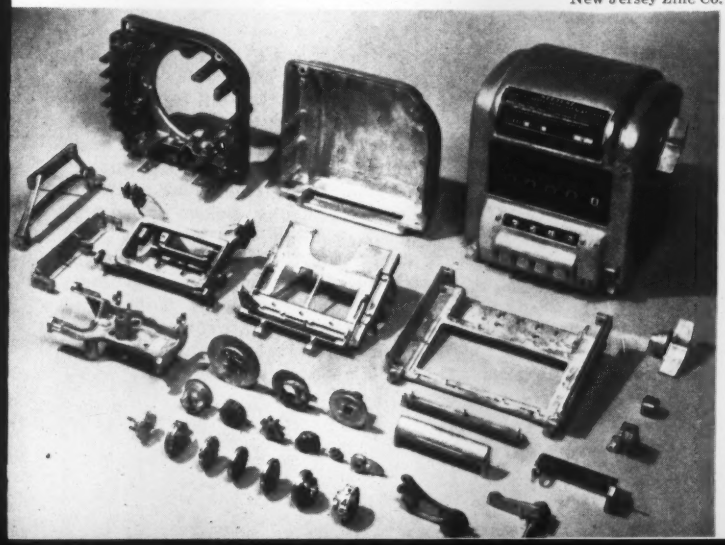
Gries Reproducer Corp.

Eyeglass frame hinge *is die cast in one operation and requires no hinging insert. Hinge is removed from die in one piece in fully articulated working condition. Open (left) and closed (right) hinges have been ground down at joint to show perfect fit.*

Zinc die castings are inexpensive, strong, complex, accurate

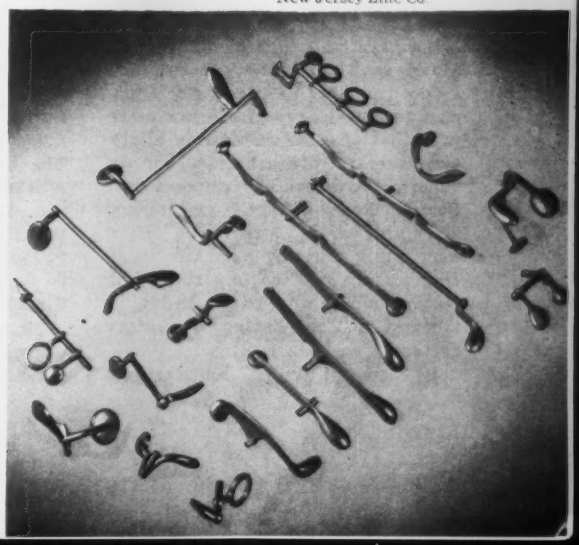
Liquid meter *is made up almost entirely of zinc die castings. Note use of such as-cast features as bosses, studs, cored holes, lettering, strengthening ribs and cast-in-place inserts. Parts are ready for assembly with minimum machining.*

New Jersey Zinc Co.



Musical instrument keys *made of zinc castings are highly accurate, inexpensive, and require no machining or brazing.*

New Jersey Zinc Co.



Die casting alloys: their properties, finishes, uses

Zinc alloys

Because of their attractive combination of properties and low cost, zinc alloys are more widely used for die castings than any other alloys.

Properties

The low cost of zinc die castings is a combination of many factors including: low materials cost, low die cost, ease of casting, and ease of finishing. Zinc die castings are usually cheaper than other equivalent alloy die castings. However, under some conditions, aluminum and magnesium die castings may be less expensive than equivalent zinc castings.

Zinc die castings can be produced with greater complexity, higher accuracy, and in a greater variety of shapes than die castings of other alloys. They also have close as-cast tolerances. Because of their good castability they can be produced smaller than any of the other alloys. In fact many small zinc die castings can be made more complex and more cheaply than screw machine parts. Zinc can be readily cast into larger shapes than brass or magnesium; however, mainly because of its light weight, aluminum is used for the largest (in terms of volume) die castings, particularly in automotive applications.

The comparatively low liquid temperature and aluminum content of zinc alloys make for low die costs and low die upkeep. Dies used with zinc alloys do not have to be heat treated, although they are usually hardened to prevent soldering and lower wear.

As shown in Table 1, the tensile strength of zinc die casting alloys is comparatively high, ranging from 41,000 to 47,000 psi. Although not as good as that of brass, zinc's impact strength compares favorably with that of other die casting alloys at moderate temperatures, and is superior at elevated temperatures. Some decrease in tensile and impact strength values is evident after long aging periods. Normally these changes are not too important, but they should be allowed for in highly stressed castings having low safety factors.

In general, zinc die castings should not be continuously exposed to steam and are not recommended in any atmosphere continuously at temperatures over 212 F.

The surface corrosion resistance of unfinished zinc die castings is adequate for many indoor applications. Ordinary atmospheric exposure causes tarnishing, and prolonged exposure to water or steam produces white corrosion products. However, surfaces can be readily protected with a suitable surface treatment such as a conversion coating of the chromate type.

Zinc die castings are popular because of the ease with which they can be finished. Although they do not retain a mechanical finish as well as aluminum die castings, they are more easily electroplated.

Types of alloys

The only two zinc alloys recommended for die castings are AG40A (XXIII) and AC41A (XXV). Both alloys contain about 4% aluminum which greatly reduces attack of the alloys on the iron in dies and other machine parts exposed to molten zinc. Both alloys are made of high purity (99.99%) zinc, and their lead, tin and cadmium content is held to very low levels. Excessive amounts of these impurities have a tendency to cause intergranular corrosion in castings exposed to warm, moist atmospheres. At one time intergranular corrosion was a serious problem with zinc die castings. However, it is a rarity today, as all reputable zinc die casters use certified zinc die casting alloys prepared to rigid specifications. In fact, many die casters do not allow any lead, tin or cadmium in their plants; they do not even use inserts plated with cadmium or tin.

The most important difference between the AG40A and AC41A alloys is their copper content: 0.25% max for the AG40A alloy and 0.75 to 1.25% max for the AC41A alloy. The higher copper content of the AC41A alloy tends to increase tensile strength and hardness. Nevertheless, the AG40A alloy is the most popular alloy and is used in roughly 80 to 85% of zinc die castings.

Finishes

Zinc die castings can be treated in a variety of ways to improve corrosion resistance and decorative properties. A popular and inexpensive way of preventing formation of corrosion products is the Cronak process. This process consists of a simple dip in a solution containing hexavalent chromium ions and produces a protective golden brown film about 0.02 mil thick. There are similar conversion coatings available which improve corrosion resistance and/or provide a good paint base. A wide range of organic coatings in a variety of colors can be used on zinc die castings.

TABLE 1—PROPERTIES OF ZINC DIE CASTING ALLOYS[a]

Alloy →	AG40A (XXIII)	AC41A (XXV)
COMPOSITION, %[b]	Cu 0.25, Al 3.5-4.3, Mg 0.03-0.08, Fe 0.1, Pb 0.007, Cd 0.005, Sn 0.005, Zn (99.99+%) bal	Cu 0.75-1.25, Al 3.5-4.3, Mg 0.03-0.08, Fe 0.1, Pb 0.007, Cd 0.005, Sn 0.005, Zn (99.99+%) bal
MECHANICAL PROPERTIES		
Ten str, psi		
As Cast	41,000	47,600
After 10-Yr Indoor Aging	35,000	39,300
Compr Str, psi	60,000	87,000
Charpy Impact Str, ft-lb		
As Cast	43	48
After 10-Yr Indoor Aging	41	40
Elong (in 2 in.), %		
As Cast	10	7
After 10-Yr Indoor Aging	16	13
Expansion (growth) after 10-Yr Indoor Aging, in./in.	0.0001	0.0001
Brinell Hardness	82	91
PHYSICAL PROPERTIES		
Density, lb/cu in.	0.24	0.24
Melting Point, F	718	717
Ther Cond (64 F), Btu/hr/sq ft/°F/ft	65	63
Coef of Ther Exp, per °F	15.2×10^{-6}	15.2×10^{-6}

[a]Source: New Jersey Zinc Co.
[b]Maximum values. Composition based on ASTM and SAE specifications. Commercial alloys are often held to closer limits than those specified.

A number of electroplates can be used, such as copper, nickel, chromium, brass, gold and silver. The most commonly used is the familiar copper-nickel-chromium coating. Although this coating provides good performance it has always been open for improvement. Recently, four new chromium electroplating processes have been announced which appear to provide better and longer lasting appearance and corrosion protection than conventional copper-nickel-chromium electroplates. These processes have been developed by Metal & Thermit Corp., Doehler-Jarvis Corp., Brown-Lipe-Chapin Div., General Motors Corp., and by Battelle Memorial Institute for the American Zinc Institute. (These processes are described in M/DE, Feb '59, p 162 and Sept '59, p 136.)

Applications

Zinc die castings are used in thousands of applications in almost every industry. By far the biggest use is in automobiles for such parts as carburetors, fuel pumps, knobs, handles and trim. The next biggest field is home appliances, where they are used not only for decorative exterior parts, but also for functional mechanical parts. Next in order of decreasing use are machinery and tools, hardware, office equipment and business machines, and photographic, optical and recording equipment.

Aluminum alloys

Properties

As shown in Table 2, nine aluminum die casting alloys are available to meet a wide range of applications. Although these alloys share many common properties, they have some important differences. In some cases the product engineer may specify the alloy to be used. However, in most applications it is best to let the die casting engineer choose the alloy that will best meet product specifications and production requirements.

Aluminum die castings are generally less expensive than magnesium or brass die castings. In some designs their cost may be equal to, or even less than, that of zinc die castings. However such cases are not very common, and aluminum die castings are generally more costly than equivalent zinc castings.

As shown in the table the tensile strength of aluminum alloys varies from 33,000 to 48,000 psi. The two most commonly used alloys—S12B and SC84B—are considerably below brass in tensile strength, roughly the same as zinc, and better than magnesium. However, aluminum die castings have a higher strength-to-weight ratio than either zinc or brass castings. They also have high thermal conductivity.

Aluminum die castings are noted for their excellent corrosion resistance. In general unfinished aluminum castings are slightly less corrosion resistant than brass castings but more corrosion resistant than zinc or magnesium castings. It is difficult to compare the corrosion re-

TABLE 2—PROPERTIES OF ALUMINUM DIE CASTING ALLOYS[a]

Alloy ➡	S12B[l]	SC84B[m]	SG100B[n]	SC114A	G8A[o]	S5C
COMPOSITION, %	Cu 0.6, Fe 2.0, Si 11.0-13.0, Mn 0.35, Mg 0.1, Zn 0.5, Ni 0.5, Sn 0.15, other 0.25, Al bal	Cu 3.0-4.0, Fe 2.0, Si 7.5-9.5, Mn 0.5, Mg 0.1, Zn 1.0, Ni 0.5, Sn 0.35, other 0.5, Al bal	Cu 0.6, Fe 2.0, Si 9.0-10.0, Mn 0.35, Mg 0.4-0.6, Zn 0.5, Ni 0.5, Sn 0.15, other 0.25, Al bal	Cu 3.0-4.5, Fe 1.3, Si 10.5-12.0, Mn 0.5, Mg 0.1, Zn 1.0, Ni 0.5, Sn 0.35, other 0.5, Al bal	Cu 0.25, Fe 1.8, Si 0.35, Mn 0.35, Mg 7.5-8.5, Zn 0.15, Ni 0.15, Sn 0.15, other 0.25, Al bal	Cu 0.6, Fe 2.0, Si 4.5-6.0, Mn 0.35, Mg 0.1, Zn 0.5, Ni 0.5, Sn 0.15, other 0.25, Al bal
MECHANICAL PROPERTIES						
Ten Str, psi	43,000	46,000	44,000	48,000	—	33,000
Yld Str (0.2% offset), psi	21,000	23,000	25,000	24,000	—	14,000
Elong (in 2 in.), %	2.5	2.5	2.5	2.5	—	9.0
Shear Str, psi	25,000	28,000	28,000	29,000	—	19,000
Fatigue Str, psi[b]	19,000	20,000	20,000	20,000	—	17,000
PHYSICAL PROPERTIES						
Density, lb/cu in.	0.097	0.097	0.095	0.097	0.093	0.097
Melting Point, F	1085	1100	1105	1080	1150	1175
Ther Cond (68F), Btu/hr/sq ft/°F/ft	70	56	68	56	56	84
Coef of Ther Exp (68-212 F), 10^{-6} per °F	11.4	11.6	11.6	11.2	13.3	12.2
Elec Cond, % IACS	33	23	28	23	24	38
OTHER PROPERTIES[c]						
Corr Res[d]	3	4	2	4	1	3
Corr Res with Chem Oxide Coating[e]	3	5	3	4	1	3
Machinability[f]	4	3	3	3	1	5
Ease of Polishing[g]	5	3	3	3	1	4
Ease of Plating[h]	3	1	1	2	5	2
Appearance After Anodizing[i]	5	3	3	4	1	2
Strength at Elevated Temp[j]	3	2	2	2	4	5
DIE CASTING CHARACTERISTICS[c]						
Res to Hot Cracking[k]	1	2	1	2	5	2
Pressure Tightness	1	2	1	2	5	3
Die Filling Capacity	1	2	1	1	4	3

[a] Except for physical properties, data are from ASTM B85-58T.
[d] R. R. Moore rotating beam test data 500 x 10^6 cycles.
[c] Rated from 1 (best) to 5 (least desirable).
[d] Standard salt spray test.
[e] Combined resistance to corrosion of coating and base metal.
[f] Composite rating based on ease of cutting, chip characteristics, quality of finish and tool life.
[g] Composite rating based on ease and speed of polishing and quality of finish.
[h] Ability to take and hold standard electroplate.
[i] Rated on lightness of color, brightness, and uniformity of clear anodized coating applied in sulfuric acid electrolyte.
[j] Based on tensile and yield strengths at temperatures up to 500 F.
[k] Ability of alloy to withstand contraction stresses while cooling.
[l] Except for 1.3% iron content, composition and properties of S12A alloy are identical to those of S12B.
[m] Except for 1.3% iron content, composition and properties of SC84A alloy are identical to those of SC84B.
[n] Except for 1.3% iron content, composition and properties of SG100A alloy are identical to those of SG100B.
[o] Mechanical property data for G8A alloy are in process of being accumulated.

sistance of the alloys if protective coatings are used.

Types of alloys

Of the various alloys listed in Table 2, the S12B and SC84B are the standard and most commonly used alloys; the remaining alloys are special, higher cost alloys and are usually used where specific end properties are needed. Here is a rundown on how the alloys compare:

S12B and S12A alloys have essentially the same composition except for slightly different iron content. The alloys are especially suited for die casting large parts having complex shape and thin walls. They have excellent casting properties because of their superior fluidity and freedom from hot-shortness.

SC84B and SC84A alloys have excellent casting characteristics and good mechanical properties. They differ only in their iron content and contain 7.5 to 9.5% silicon and 3 to 4% copper. The alloys were originally developed in World War II from aircraft scrap containing about 4% copper. When the magnesium in the scrap was removed and up to 9.5% silicon added, the resulting alloys proved extremely suitable for die casting and are now being used in large quantities.

SG100B and SG100A alloys contain 9 to 10% silicon and provide somewhat better ductility and corrosion resistance than the standard alloys described above.

SC114A alloy contains up to 12% silicon and 4.5% copper. It has excellent fluidity, is easy to die cast, and is particularly suited for large, thin-walled castings of complex design.

G8A has the best combination of strength, ductility, corrosion resistance and finishing properties of the aluminum alloys. However, it is difficult to die cast.

S5C, like G8A, is difficult to die cast, but its good ductility is advantageous in assembly operations where forming or upsetting must be performed.

Finishes

When exposed to air aluminum die castings form a thin, transparent oxide film which improves corrosion resistance. Thus, in many applications, the castings can be left unfinished. If necessary, they can be given a highly decorative appearance by mechanical finishing. Organic coatings can also be used for decoration. Electroplated coatings can be applied to aluminum die castings, although not as readily as to zinc castings.

Chemical treatments are frequently used to decorate and give additional protection to aluminum die castings. Immersion in a hot alkaline solution of dichromate produces an oxide coating which improves corrosion resistance and serves as a good paint base. Other similar chemical treatments are available.

Anodizing can also be used to improve the decorative and functional properties of aluminum die castings. The oxide film formed by anodizing is thin, inert, has high dielectric strength, and increases hardness and abrasion resistance. The film readily absorbs coloring dyes, paints and waxes. Depending on the alloy used, the film can be made clear and transparent or in various colors. The grain structure of anodized die castings is readily apparent and, except for brown and blue coatings, dyed coatings do not have a very good appearance.

Applications

Next to zinc, aluminum is the most widely used die casting alloy. Its combination of good strength, corrosion resistance, appearance and light weight has resulted in a large number of applications, some of which are shown in the accompanying photographs.

Probably the best and most dramatic illustration of how aluminum die castings can be effectively used is the automotive engine block. Experimental 6-cylinder blocks weighing 43 lb have been produced and experimental V-8 blocks are forthcoming. In addition to their light weight and strength, these blocks are extremely resistant to water and other corrosive materials, and have a very complex shape with accurate dimensions. They eliminate considerable machining, and it is possible that in large quantities they will be competitive with conventional gray iron blocks produced by sand casting.

Magnesium alloys

Properties

The most important advantage of magnesium die castings is their light weight and low cost. Light weight is a very important factor in products that must be easily portable, and in transportation and military equipment. The density of magnesium is roughly 69% that of aluminum, 27% that of zinc and 22% that of brass. Naturally, these figures do not mean that a magnesium casting will weigh, for example, only 22% as much as an equivalent casting, as there is a considerable difference in the strength of brass and magnesium. However, magnesium does have a higher strength-to-weight ratio than the other die casting alloys. As shown in Table 3, it has roughly the same mechanical properties as the S12B aluminum alloy, and considerably lower density.

Magnesium can often be cast in the same dies as aluminum, and for this reason has replaced aluminum in some applications where light weight is important. Furthermore, despite higher materials cost, magnesium castings in some cases have been made at the same or lower cost than zinc or aluminum castings.

Magnesium can be machined at higher speeds and with less expense than the other die casting alloys. Magnesium (as well as aluminum and brass) die castings also have high thermal conductivity—important where good heat dissipation is needed. In addition, adequate structural strength can be maintained at temperatures over 500 F by using a newly developed high temperature

TABLE 3—PROPERTIES OF MAGNESIUM ALLOY DIE CASTINGS[a] (AZ91B[b])

COMPOSITION, %[c]	Al 8.3-9.7, Zn 0.35-1.0, Mn 0.13 (min), Si 0.5, Cu 0.3, Ni 0.03, other 0.3, Mg bal
MECHANICAL PROPERTIES	
Ten Str, 1000 psi	32-36
Ten Yld Str (0.2% offset), 1000 psi	22-24
Compr Yld Str, 1000 psi	22-24
Shear Str, 1000 psi	20
Elong (in 2 in.), %	3
Rockwell Hardness	E75
Fatigue Str, 1000 psi[d]	14
PHYSICAL PROPERTIES	
Density, lb/cu in.	0.066
Ther Cond, Btu/hr/sq ft/°F/ft	41
Coef of Ther Exp (68-392 F), per °F	15.2×10^{-6}
Elec Cond, % IACS	10

[a] Except for physical properties, data are from ASTM B94-58.

[b] Except for 0.1% max copper content, AZ91A alloy has identical composition and properties. AZ91B is considered standard die casting alloy. See text for information on newly developed high temperature alloy (HM11XA).

[c] All values are maximum except where otherwise noted.

[d] R. R. Moore rotating beam test data 500 x 10^6 cycles.

Why Die Castings?

Advantages

Die castings have a number of important advantages and some limitations, many of which are unique and many of which are shared by other metal forms. In general, the popularity of die castings stems from their:

1. Rapid production in large quantities with an identical shape and size.
2. Low cost in large quantities.
3. Close dimensional tolerances and ability to be used with little or no post-machining.
4. Smooth as-cast surfaces.
5. Producibility in complex shapes with low scrap losses.
6. Low section thickness and high structural efficiency.
7. Ability to accept a wide variety of coatings and finishes.

Limitations

As with any metal form, die castings have some limitations which may or may not be important for a given application. These are:

1. Unsuitability for small production runs because of high die cost.
2. Limited availability in six nonferrous metals—zinc, aluminum, magnesium, copper, lead and tin.
3. Necessity for special designs and engineering talent.
4. Unsuitability for very large parts. However, it should be noted that die castings can be made in all sizes up to that of an automobile engine block. This size encompasses most product applications.
5. Susceptibility to internal porosity. Such porosity usually is not a factor in decorative applications and its effect on mechanical strength is predictable and can be allowed for. Porosity can cause leaks in hydraulic applications but these leaks can be eliminated by using a suitable casting impregnant.

How they compare with . . .

Sand castings. Although die castings require much more expensive dies (molds) and production equipment than sand castings, the nature of the die casting process lends itself to fast, high-quantity production which can quickly amortize initial equipment costs. Furthermore, die castings can be produced with closer tolerances, thinner walls, smoother surfaces, and higher mechanical properties than equivalent sand castings. However, sand castings can be made from ferrous metals and a wider range of nonferrous alloys and are more economical for small production runs. They are also available in large sizes and in some shapes not suitable for die castings.

Permanent mold castings. In general, die castings have the same advantages over permanent mold castings as they do over sand castings. In addition, despite their greater porosity, die castings usually have better mechanical properties than equivalent permanent mold castings. However, permanent mold castings are more economical for low production runs. Also, sand cores can be used in permanet molds to produce shapes not obtainable in die castings, but these cores are not cheap and have to be replaced.

Stampings. There are numerous applications where die castings cannot be competitive with stampings. This is particularly true in the case of flat and very thin parts which are obviously best made by stamping. However, there are many products that can be made either by die casting or stamping.

Compared to stampings, die castings usually require less expensive dies, and can be made in more complex shapes with less wastage—and in one piece (thereby cutting down assembly operations and costs). They can also be made with closer tolerances and with a greater range of section thickness to meet varying operating stresses. On the other hand, stampings may (not always) be produced at faster rates and, since they are made of wrought metals such as steel, can have higher strength and lower weight for a given section thickness. In addition, since stampings are not porous, they usually have a smoother surface and may withstand certain types of abuse better than die castings.

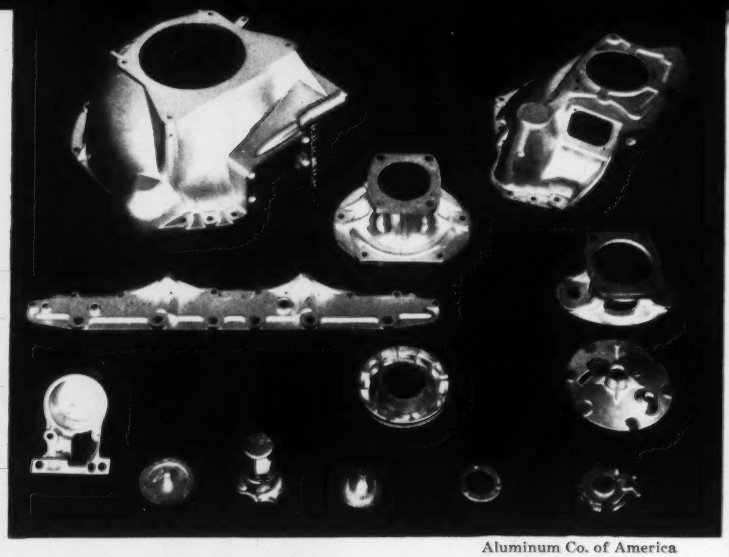
Forgings. Compared to forgings, die castings have the advantages of much greater complexity, more accurate dimensions and lower section thicknesses. Die castings can also be produced at faster rates and dies may be less expensive and longer lasting.

Naturally, a forged part has higher strength than an equivalent die casting of the same size (except, perhaps, for some brass die castings). Thus, forging is better suited for simple parts requiring high strength. Forgings are also available in sizes not suitable for die castings.

Screw machine parts. Innumerable products can be made either by die casting or by the screw machine method. Screw machine parts are noted for their low cost, but die castings may—despite their higher materials cost—actually be cheaper because of their lower metal wastage. Furthermore, many screw machine parts require secondary machining operations which can be minimized or completely eliminated by die casting. Naturally, die castings can be produced in a greater variety of shapes and sizes. However, screw machine parts have more accurate dimensions than unfinished die castings, as well as greater strength and smoothness.

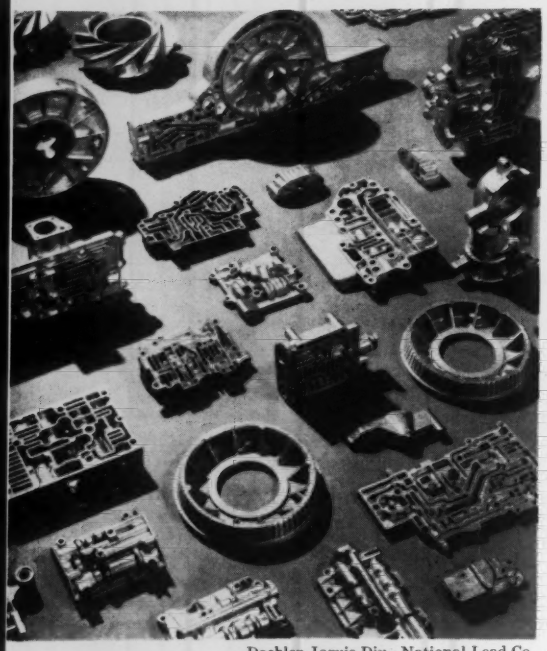
Plastics moldings. The choice between a die casting and a plastics molding is important and involves many factors. Within the past few years, there has been an increasing substitution of plastics moldings for die castings. This switch has been particularly evident in such applications as toys, housings, fittings, hardware, and decorative and corrosion resistance applications. Despite these inroads, most products now being made by die casting will continue to be made by die casting. The reason is that die casting permits greater coring and the production of more complex shapes. Moreover, a die cast part of the same size is stronger, can be produced faster, and is more dimensionally accurate and stable than a plastics molding.

The main advantages of plastics moldings over die castings is that they may be cheaper for some applications. Although die costs are high, materials costs are low. Many plastics moldings are also very corrosion resistant, are available in many colors, and can be given a decorative metal finish. The dielectric properties of plastics may also be important in some uses.



Aluminum Co. of America

Auto engine and transmission *parts shown range in weight from 0.15-lb power unit housing (lower right) to 9.7-lb torque converter housing (upper left).*



Doehler-Jarvis Div., National Lead Co.

Automobile transmission *valve parts made of aluminum typify complexity obtainable with die castings.*

Aluminum die castings are light, strong, corrosion resistant

alloy (see following section on types of alloys). Like wrought magnesium, die castings have good energy absorption properties. They also have good dimensional stability and are noted for their nonmagnetic and nonsparking properties.

Under severe conditions, magnesium die castings have poorer corrosion resistance than the other die casting alloys. Magnesium castings have demonstrated good corrosion resistance in normal atmospheres (particularly in automotive applications) but are not recommended in salt water exposure. Under mild corrosive conditions magnesium develops a dark gray film composed of oxide, hydroxide and carbonate compounds. Although this film is mildly protective it does not provide as good protection as an oxide film on aluminum. Extensive attack can occur under severe corrosive conditions, but in many cases the metal can be satisfactorily protected with a suitable coating.

Magnesium die castings can be produced in the same cold chamber machines and dies as aluminum. However, the molten metal has to be protected with a hood and a nonoxidizing atmosphere, since it oxidizes rapidly when exposed to air. Precautions are also required during machining to prevent ignition.

Types of alloys

Two types of magnesium alloys—AZ91A and AZ91B—are available for die casting. Both alloys contain aluminum as the major alloying element. They have identical mechanical properties. The only difference is that the AZ91B alloy has a maximum copper content of 0.3%, whereas the AZ91A alloy is limited to a maximum of 0.1% copper. Actually, except for some military applications, the AZ91A alloy is rarely specified. AZ91B has the lower cost and is considered to be the "workhorse" alloy.

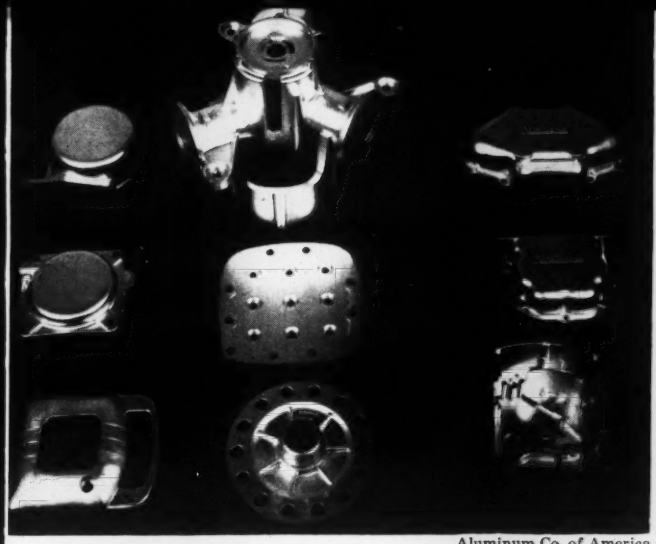
Dow Metal Products Co. has recently developed a new magnesium-thorium alloy suitable for use at high temperatures—500 to 800 F. It is currently being evaluated for aircraft and missile applications (see M/DE, Aug '59, p 134). The alloy differs markedly from AZ91B in that it contains 1% thorium, 1% manganese, balance magnesium. Typical tensile strength values obtained are 30,200 psi at 70 F, 16,800 psi at 400 F, 12,400 psi at 600 F, and 7800 psi at 800 F. Aside from composition and high temperature strength, properties of the alloy are generally similar to those of AZ91B.

Finishes

Magnesium die castings must be given a surface treatment or coating to prevent the formation of corrosion products. Magnesium castings are most commonly protected with a chemical conversion coating, an oiled finish or an organic coating. Anodic treatments, including the HAE process, can also be used. Electroplated coatings are used to a limited extent, but a newly developed electroless nickel coating shows considerable promise in protecting and decorating magnesium surfaces.

One of the most popular chemical treatments is a chrome pickle (such as Dow No. 1) which produces a passive etched surface; it protects the metal and can serve as a base for a subsequent organic coating. This treatment is not recommended where high accuracy on machined surfaces is needed as it removes from 0.6 to 2 mils of metal. Added corrosion resistance after chrome-pickling can be obtained by a sealing treatment in a dichromate solution.

A protective brown to black coating that does not change casting di-



Aluminum Co. of America

Various machine and equipment *parts shown here are all made of aluminum die castings.*

Aluminum Co. of America

Outboard motor *consists almost entirely of aluminum die castings. Parts readily identifiable include cylinder block, cylinder head, gas tank, connecting rod, propeller, piston, main leg and stern clamp.*

mensions is obtainable with a hydrofluoric acid-dichromate treatment. A hydrofluoric acid-alkaline dichromate treatment is also available. Alternatively, a decorative black finish is obtainable with a chrome-alum treatment. This treatment provides a good paint base but it is not as protective as the other chemical treatments.

Selection of the best chemical treatment depends on service conditions. Although the above treatments can be used alone, best protection is obtained by using them in conjunction with an organic coating. The chrome pickle provides a good organic coating base for interior and some mild outdoor applications. In some cases no treatment is needed if the organic coating is compatible with the metal. For severe outdoor service, maximum protection and paint adhesion is obtained by using a hydrofluoric acid-dichromate treatment or a sealed chrome pickle.

Applications

Magnesium die castings are used in numerous lightweight low-cost applications requiring a high strength-to-weight ratio (see photos). They are particularly useful in lightweight portable items such as typewriters, chain saws, cameras and projectors. Other lightweight applications include aircraft and missile hydraulic components, and missile fin frames. Typical low-cost automotive applications include window lift mechanisms, fuel pump housings, oil reservoir covers and oil seals.

Brass

About 1% by weight of the die castings produced today are made of copper-base alloys. Although several classes of copper-base alloys have been die cast, the brasses have proved to be the most practical and are now used for almost all copper-base die castings.

Properties

Compared to other alloy die castings, brass castings have the highest strength, impact resistance, ductility, hardness, and wear and corrosion resistance (see Table 4 for properties). They also have good bearing properties, a pleasing color, and are easily soldered and plated. Some brass die castings have better mechanical properties and more accurate dimensions than mild steel forgings. In some cases brass die castings have replaced brass forgings because they can be made with greater accuracy, more complexity and thinner sections.

With its impressive array of properties you might expect that brass would be the most widely used die casting material. However, the material has some inherent limitations.

The principal disadvantage of brass die castings is their high cost. Not only is the raw material relatively expensive, but it is relatively difficult and costly to cast. Brass alloys have a high melting point—about 1575 F—and require special die steels and dies which are expensive to make and need special heat treatment. Another disadvantage of brass die castings is their comparatively high density (0.297 lb per cu in.). This can be a limiting factor in lightweight applications. Also, most castings are limited to comparatively small sizes—usually less than 5 lb, but occasionally up to 15 lb.

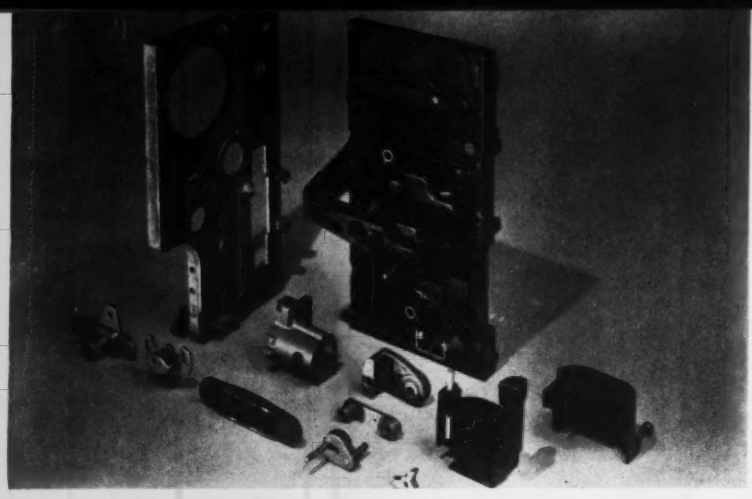
TABLE 4—PROPERTIES OF BRASS DIE CASTING ALLOYS[a]

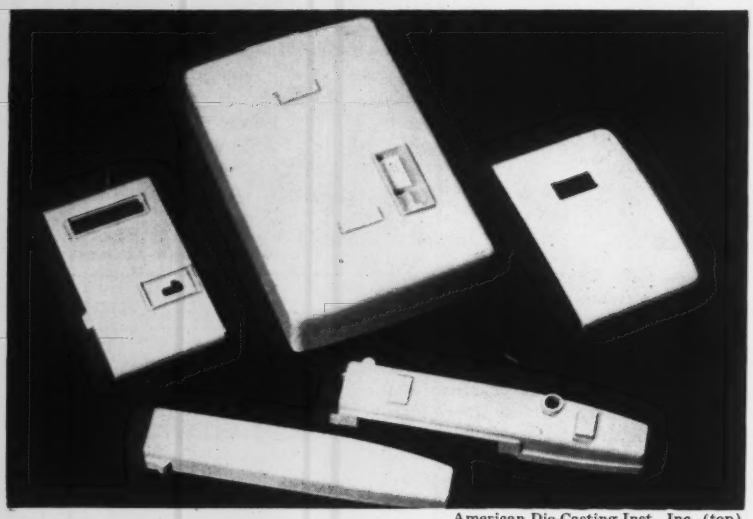
Alloy →	Z30A	ZS331A	ZS144A
COMPOSITION, %[b]	Cu 57.0 min, Si 0.25, Pb 1.50, Mn 0.25, Al 0.25, Fe 0.25, other 0.50, Zn 30.0 min	Cu 63.0-67.0, Si 0.75-1.25, Pb 0.25, Sn 0.25, Mn 0.15, Al 0.15, Fe 0.15, other 0.50, Zn bal	Cu 80.0-83.0, Si 3.75-4.25, Pb 0.15, Sn 0.25, Mn 0.15, Al 0.15, Fe 0.15, Mg 0.01, other 0.25, Zn bal
MECHANICAL PROPERTIES			
Ten str (min), psi	45,000	58,000	90,000
Yld Str (0.2% offset), psi	25,000	30,000	50,000
Elong (in 2 in.), %	10	15	25

[a]Source: ASTM B176-57.
[b]All values are maximum except where otherwise noted.

Types of alloys

As shown in Table 4, three types of brasses are available for die castings—Z30A, ZS331A and ZS144A.





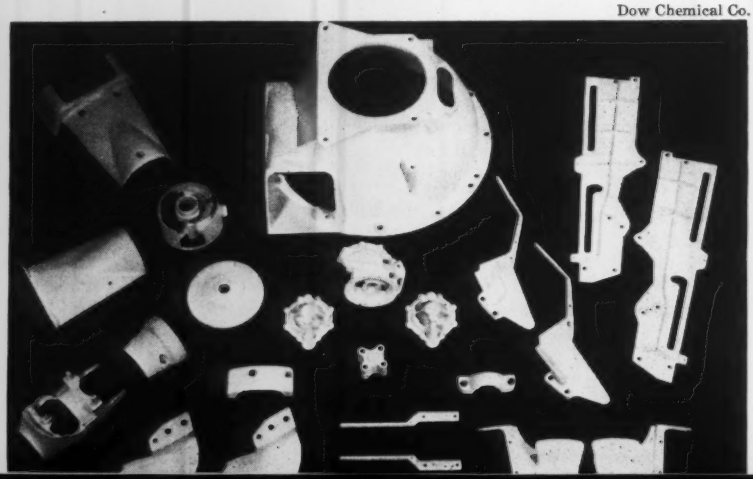
American Die Casting Inst., Inc. (top)
Dow Metal Products Co. (bottom)

Motion picture projector *(top) containing integral speaker weighs only 33½ lb when made of magnesium die castings. Combination camera-projector (bottom) incorporates five magnesium die castings to provide light weight and strength.*

Magnesium die castings have high strength-weight ratio, good heat dissipation, are easy to machine

Automobile parts *shown are all magnesium die castings. Parts include window lift mechanisms, housings, brackets and shrouds.*

Dow Chemical Co.



Z30A is a 60:40 yellow brass alloy containing relatively high percentages (1.5% max) of lead and tin. It is a general purpose alloy and, despite its high melting point, is quite popular because of its comparatively low cost, and good machinability and soldering properties. However, it has lower strength than the other two brass alloys.

ZS331A is also a general purpose alloy. Compared to ZS30A it has higher strength and is easier to die cast, but it is slightly more difficult to machine.

ZS144A has higher strength, hardness and wear resistance than the above two alloys but is difficult to machine. It is generally used only where high strength or wear resistance is needed.

Finishes

Most brass die castings are used in nondecorative applications where the parts are not exposed. In such applications the castings can be used as is, or else given a simple chromate conversion coating for added corrosion resistance. The castings have a pleasing enough appearance for some applications, but when added decoration is needed they can be readily given a mechanical finish, organic coating or electroplate. Organic coatings are not widely used on brass die castings; however, a chromium electroplate is popular for many functional-decorative applications such as plumbing fixtures.

Applications

Brass die castings are used in applications where a special property such as strength or corrosion resistance is needed which cannot be obtained with any other alloy. Typical high strength and/or wear resistant applications are: gears, transmission forks, clutch and shock absorber parts, and bearings. Corrosion resistance applications include: pumps, steam fittings, valves and plumbing fixtures. Typical of other uses are: switchboard and contactor parts, brush holders, refrigerator parts, general fittings and miscellaneous hardware.

Lead and tin alloys

Lead and tin alloys can be readily die cast. The alloys were fairly popular at one time, but their use has steadily dwindled and they are rarely used today.

Aside from their good casting properties, lead alloys have high

corrosion resistance (especially to sulfuric acid) and good bearing properties. Their high density and deformability can also be advantageous in some applications. However, the alloys are generally limited by their low strength, softness and comparatively high cost. Their poor creep and cold flow properties are also disadvantageous, especially where bending or tension stresses are applied. Use of the alloys at present is limited to x-ray equipment, gaskets and low-grade bearings.

Tin alloys have roughly the same mechanical properties as lead alloys, but are even higher in cost. The alloys also have excellent bearing properties and can be cast with very accurate dimensions. They were once quite popular for bearings but because of high metal cost are rarely used today.

Designing the die casting

Most product or design engineers cannot be expected to be completely familiar with all the complexities of the die casting process. In order to design a product most efficiently for die casting it is essential that the product engineer take advantage of the specialized talents of the die casting engineer. Ideally, this should be done at the earliest design stage. However, such early consultation is not absolutely essential, as there are innumerable cases where the decision to use die casting was after the product was completely designed. In any event, the die casting engineer can show you how with minimum changes and sacrifices a product can be designed most efficiently to take full advantage of the die casting process and reduce cost.

This is not to say that the product engineer can leave everything completely in the hands of the die casting engineer. In the early design stages, particularly, the product engineer must be completely familiar with the do's and don'ts of die casting in order to create an efficient design and avoid obvious mistakes.

Following is a summary of the important factors that must be considered when designing a die casting. Keep in mind that the single most important selection factor in any die casting is the choice of the proper alloy, and that the following factors usually come into play only after the alloy has been selected.

Tolerances

The excellent dimensional tolerances obtainable with die castings are well known. As with any other fabricated part, the engineer should try to operate within the limit of normal as-cast tolerances, since any special tolerance requirements raise the cost of the die and the casting.

Linear tolerances — The linear tolerances obtainable with die castings depend on the alloy used. For example, the *basic* tolerances on critical dimensions up to 1 in. are ± 0.003 in. for zinc, ± 0.004 in. for aluminum and magnesium, and ± 0.007 in. for copper. For *each* additional inch between 1 and 12 in. the following tolerances must be added: ± 0.001 in. for zinc, ± 0.0015 in. for aluminum and magnesium, and ± 0.002 in. for copper. Naturally, the tolerances on noncritical dimensions are higher. Also, additional tolerances are required on dimensions extending across moving parts of the die. (For detailed linear tolerance information see American Die Casting Institute Product Standards E1, E2 and E3.)

Concentricity tolerances—The concentricity of cylindrical surfaces is affected by many factors, such as wall thickness and the shape, size and complexity of the die casting. An example of the tolerances obtainable is provided by two cylindrical surfaces in fixed relationship in the same die section (the simplest case). If the diameter of the larger cylinder is 3 in. or less then the smaller cylinder will be concentric within 0.004 in. TIR. Additional tolerances must be added for dimensions over 3 in. Tolerances also vary when cylinders are formed in opposite die sections or by moving die members (for detailed information on concentricity tolerances see ADCI-E12-57T).

Angularity tolerances—These tolerances refer to the angular difference between plane surfaces, i.e., their "off-parallel" difference. They are not to be confused with draft allowances which are designed into the casting to allow easy removal of the casting from the die. Angularity is a natural result of the die casting process, and its magnitude is influenced by such factors as size of the casting and strength and rigidity of the die under heat and pressure. Considering a simple case where surfaces are in fixed relationship in the same die section or part of the same moving die member, a tolerance of ± 0.005 in. can be held on surfaces 3 in. long or less. An additional tolerance of 0.001 in. must be added for each inch of length over 3 in. (For a complete description of angularity tolerances see ADCI-E11-57T.)

Section thickness

Since the cost of a die casting is a function of the amount of metal used, the designer should try to use the thinnest possible sections. The minimum section thickness obtainable is a function of required strength and stiffness, thickness of adjacent sections, metal fluidity, and the shape and size of the casting. Under ideal conditions the minimum thicknesses obtainable with small castings are: 0.015 in. for zinc, 0.035 in. for aluminum, and 0.05 in. for magnesium and copper alloys. Thinner sections are obtainable in some special cases. For large castings the minimum thicknesses obtainable are somewhat higher than those just cited: 0.05 in. for zinc, 0.08 in. for aluminum and magnesium, and 0.09 in. for brass.

Because of the difficulty in making a stress analysis of a die casting section, designers have an understandable tendency to use high safety factors, making sections needlessly thick. Aside from cost advantages, a thin section tends to be proportionately stronger than a thick section because its surface (the strongest part of a die casting) constitutes a larger proportion of the total section thickness. Also, the rapid cooling achieved at the surface of thin sections tends to improve mechanical properties; it also permits dies to be opened more quickly, promoting shorter production cycles. A further advantage of thin sections is that they tend to be smoother and less porous than thick sections.

Section uniformity

Like other castings, die castings should be designed with sections as nearly uniform as possible to promote uniform shrinkage. Thin sections solidify rapidly and are subject to shrinkage stresses from adjacent thick sections which cool more slowly. Naturally, there are bound to be non-

The die: heart of the process

Naturally, the most important element in any die casting machine is the die itself. The die consists of two matching sections —an ejector and a cover section— which contain an exact internal mold of the part to be produced. The two sections meet at a "parting." Preferably, the parting should be a plane; however, it must often be an irregular surface because of the way that the part is designed.

The two sections are securely locked together to prevent separation and leakage of the metal which is forced into the die under high pressure. The ejector section of the die normally contains the greatest portion of the cavity and is usually attached to the movable platens of the die casting machine. The cover section, which completes the mold and forms the smaller part of the cavity, is held by a fixed platen and is generally located close to the metal pot.

Many casting dies consist of a single cavity and produce one casting per cycle. Single-cavity dies are usually required for very complex or large castings. In most cases, several cavities can be combined in one die to produce several castings per cycle. If the cavities are all duplicates the die is called a "multiple-cavity" die; if the cavities have different shapes and sizes the die is called a "combination" die. Multiple and combination dies are especially valuable for producing small, simple castings in large quantities. Also, the combination die is useful for the simultaneous casting of several different parts of one assembly, thus simplifying production.

Dies are filled through runners leading to restrictive gates at the design cavity. Air entrapped in the die is expelled through suitable vents. These vents are made thin so that the metal flowing through them solidifies quickly, thus stopping up the flow and building up pressure in the cavity. Overflow wells are also incorporated in some dies at critical points to prevent air entrapment and porosity.

Four different casting methods

Over the course of a century, four principal types of machines and methods have proved most suitable for producing die castings. All of these machines differ in their method of injecting metal into the die. They also differ notably in the alloys they can handle and in their operating pressure, speed of operation, capacity, and other production capabilities.

Plunger machines are allied to the earliest die casting machines and are suited mainly for zinc and similar low melting alloys. Basically, the machines consist of a large container of molten metal in which is immersed a cylinder and a plunger which operates in the cylinder. A spout runs from the bottom of the cylinder to a nozzle which connects to the die opening. Raising the plunger uncovers a port in the cylinder and allows the metal to enter. When the plunger is pushed down it forces the metal out of the cylinder, through the spout, and into the die. The plunger is withdrawn when the metal hardens and the die is then opened and the casting ejected.

Plunger-type machines have a comparatively short operating cycle and are well suited for fast production. They are usually operated at pressures of 1500 to 2000 psi; higher pressures rarely produce any benefits.

Cold chamber machines are similar to injection machines except that the injection plunger and cylinder are not immersed in molten metal. Rather, an exact charge of the molten metal is ladled through a port into the "cold chamber." The plunger then advances, closes the port, and forces the metal into the die. Pressures range from about 3000 to 8000 psi for aluminum and magnesium alloys, and from 8000 to 25,000 psi for copper-base alloys.

Ordinarily, high melting alloys cannot be used with plunger-type machines because the alloys react with the piston and chamber materials and destroy mating fits. However, the cold chamber machines operate at lower temperatures since the piston and cylinder are not immersed in molten metal and are in contact with the metal for only a brief time in each cycle. Thus, the higher melting alloys can be handled safely. Because of their comparatively slow operation, the cold chamber machines offer no significant advantage in handling the lower melting alloys.

Air injection machines differ from plunger machines in that air pressure rather than a piston is used to force the molten metal into the die. They are used mainly for aluminum alloys but can be used for lower melting alloys.

Heart of the air injection machine is a U-shaped vessel or "gooseneck" which is filled with molten metal from an adjacent metal pot. One end of the gooseneck is connected to an air supply and the spout end to the die opening. Air pressure at 300 to 600 psi forces the metal into the die. Air pressure is then released and the spout lowered in the metal pot for refilling. As soon as the metal in

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uniform sections in almost any die casting, and their effect can be minimized by using generous tapers and fillets, by thinning out heavy sections and reinforcing them with ribs, or by adding cores or slides. Cores, especially, help to eliminate unwanted metal in sections that would otherwise be heavy and cause undesirable stresses. Although they add to the cost of the die their expense is partially offset by the metal saved.

Ribs, bosses and beads

These three design features help to increase strength and rigidity and are useful in a number of other important ways.

Ribs are mainly used to bolster the strength and stiffness of thin walls, but also permit weight savings, distribute stresses, and help avoid warpage and distortion by improving metal distribution and eliminating unequal shrinkage stresses. Quite frequently, ribs can be expanded into fin form—as on cylinder heads and camera projectors—to improve heat

the die solidifies, the die is unlocked and the casting ejected.

Vacuum die casting is essentially the reverse of air injection die casting. The process is relatively new and is claimed to produce improvements in die casting properties, particularly in zinc die castings. The process is still in the development stage for aluminum die castings and has not as yet been used for magnesium die castings. Standard die casting machines can be modified to use the process and existing dies need not be changed.

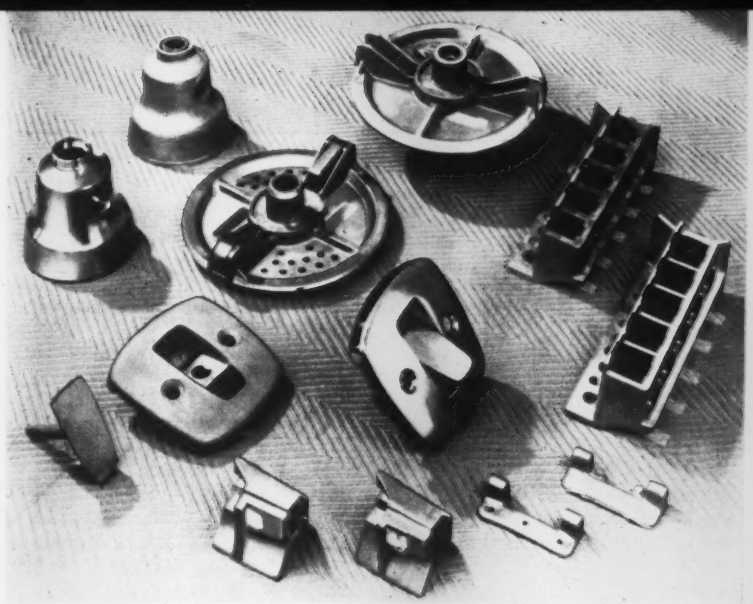
Vacuum die casting (at ½ to ¼ atm) is claimed to provide the following advantages:

1. Low porosity. Vacuum die casting reduces entrapped air and associated porosity. Immediate benefits are said to be: higher tensile strength and hardness, lower rejects, greater pressure tightness, and reduced blistering when baking organic coatings.

2. Good finish. Vacuum die castings have an excellent surface, reducing finishing costs. In many cases little buffing is required to prepare the surface for plating or painting.

3. Thin walls. Wall thicknesses can be reduced by 25 to 50% by vacuum casting. Wall thicknesses of 0.03 in. are common and 0.018-in. walls are obtainable.

The die requires only a fraction of a second to reach the required partial vacuum. Because of the lack of an air film in the die, chilling occurs more rapidly than in conventional machines. Dies can be opened rapidly and parts can be produced at rates comparable with conventional die casting methods.



Miscellaneous parts *shown before and after finishing. Parts at upper left are shower heads; square parts in center are bathtub overflow plate assemblies; parts at lower right are hinges.*

Brass die castings have high strength, corrosion resistance

Fly wheel *for garbage disposal unit was formerly made as permanent mold casting. Switch to die casting reduced cost by 76%.*

All photos courtesy Titan Metal Mfg. Co.

dissipation as well as adding strength and rigidity.

Ribs shoud have rounded tops and be curved at the corners. Heavy masses of metal should be avoided as they tend to produce unwanted bulges or "shadows" on the back of the surfaces they are reinforcing. Ribs may be positioned in any direction and are usually placed so as to join with functional bosses.

Bosses or hollow projections are mainly used as attachment points or as bearing supports. They also help to increase strength and stiffness, serve as points for ejecting, gating and venting, and act as locating points for subsequent machining operations. In many simple uses the internal surface of the boss can be threaded for attachment or used as-is as a bearing surface. For more rugged applications a threaded insert or sleeve bearing can be inserted directly into the boss. As a rule, holes should be cored rather than drilled out.

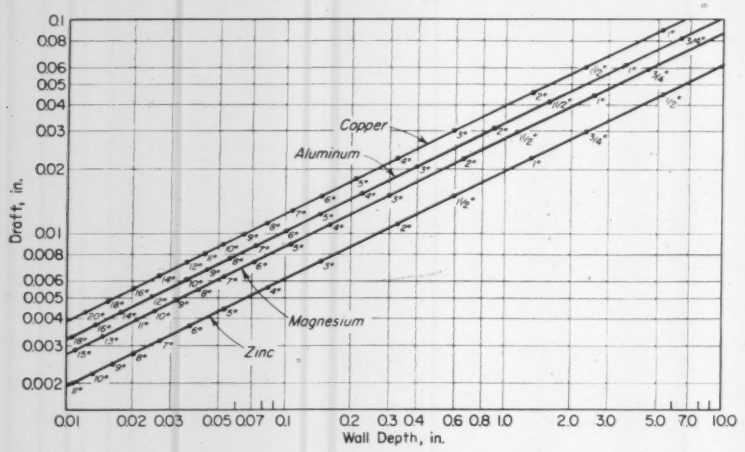


Fig 1—Draft requirements in cored holes. From ADCI-E7-55T. Holes cast in die castings are produced by the use of cores. Such cored holes require draft. The graph indicates the total of draft in the hole. The depth of cored holes shown in the graph is subject to the diameter-depth relationships shown in ADCI Product Standard E6. Requirements for tapped holes are shown in ADCI Product Standard E8.

Example: In a zinc die casting a cored cylindrical hole 2 in. deep will have a total draft of 0.042 in. for the 2 in. of depth.

Note: The values shown represent normal production practice at the most economic level. Lesser draft involving close work or care in production should be specified only when and where necessary since additional cost may be involved.

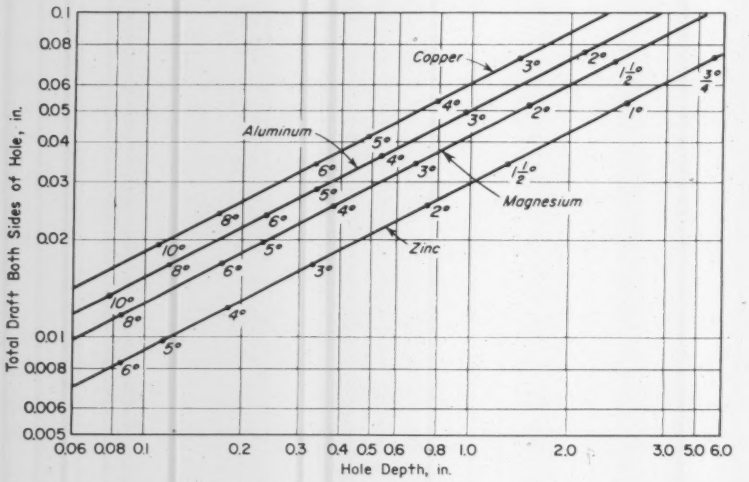


Fig 2—Draft requirements for walls. From ADCI-E4-55T. All walls on die castings normally vertical to the parting plane of the die casting require draft or taper. This draft is not constant. It will vary with alloy used and the depth of the wall as indicated. The graph is for draft on inside walls. Draft required on outside walls is one-half of that required on inside walls. Draft requirements for corners is covered in a separate standard. The provisions shown do not apply to die cast lettering, engraving or honeycomb design.

Note: The values shown represent normal production practice at the most economic level. Greater accuracy involving extra close work or care in production should be specified only when and where necessary since additional cost may be involved.

Naturally, threaded bosses must have a wall thick enough to compensate for any weakness caused by the thread. However, excessive thickness should be avoided, as thick walls tend to have excessive porosity which can be exposed when the thread is cut. Quite often the section around a boss has to be thicker than adjacent sections to minimize local stresses and distortion. However, undue metal concentration should be avoided to prevent shrinkage stresses and porosity. Heavy sections can be avoided by judicious use of cores and ribs. Bosses should also be provided with fillets and gradual transitions in section thickness.

Beads are simply small ribs which, besides increasing strength, are also decorative. Quite often they can be used to decorate plain surfaces and hide defects. They can also be used around the rims of holes to improve appearance and avoid sharp edges.

Fillets and rounded corners

As with all other types of castings, fillets and rounded corners should be liberally used. They should always be used at sharp corners to prevent unwanted stress concentrations and strengthen weak points. Fillets and rounded corners help to improve metal flow and promote smooth surfaces and better grain structure. They improve die life by eliminating sharp corners which are subject to rapid deterioration. They make die construction easier and facilitate removal of the casting from the die. Furthermore, they make polishing easier and help to promote uniform electroplates.

Here are some critical points in a die casting where fillets should be used:

1. Inside corners where two surfaces meet.
2. The point at which a boss or stud joins the casting body.
3. At the root of ribs or beads.

Rounded corners are beneficial at all points except at the die parting line. They are useful for the same reason as fillets and, in addition, prevent marring damage during fabrication and actual use. However, in many applications sharp corners are desired because of their pleasing appearance. In such cases the edges can be rounded lightly—enough to prevent damage without destroying a crisp, sharp appearance.

Draft

A draft is required on all surfaces perpendicular to the die parting to

allow the casting to be removed from the die. In general, die castings require less draft than sand castings. As shown in Fig 1, the amount of draft required depends on the alloy used, the depth of the wall, and whether or not the wall surface is inside or outside. The values given are for inside walls; the draft required for outside walls is only one-half that given for inside walls.

The draft values given are obtainable with normal production practices at reasonable cost. In some cases, lower drafts and greater accuracy can be obtained; however, such demands are expensive. In general, the engineer need specify only the maximum permissible draft on a surface that will not interfere with the mating of parts and operation of the casting. The actual draft used is usually left up to the die casting engineer, and its value need not concern the product or design engineer so long as it does not exceed the prescribed limit.

Parting line

Selection of the parting line is usually left up to the die casting engineer. However, it is essential that the product engineer have some knowledge of the factors influencing parting line selection so as to obtain the best casting design that will provide easiest and fastest production.

The parting line (or plane) is the line on the casting where the two die halves meet. This line must be selected so that the casting can be readily withdrawn from the die. It must also be placed at the most advantageous point on the casting so as to minimize subsequent trimming and cleaning operations. Placement is also governed by such factors as the location of vents, gates and ejector pins, and the size, position and type of cores used.

Normally, the parting line is placed at the plane in the casting that has the largest cross-sectional area. Placement of the parting line at any other point requires undercuts and costly die construction. Preferably, the parting line should be flat. The advantages of using a flat parting are cheaper dies, less expensive trimming dies, and easier die maintenance.

Flat areas

In general, large flat areas should be avoided, as they tend to be weak unless adequately ribbed. They also tend to call attention to any slight warpage or surface defect present in the casting. Nevertheless, their appearance can be improved by using a slight crown or a decorative pattern, such as steps, reliefs, stripes or beads, which breaks up the surface. Naturally, a glossy finish should be avoided on large flat areas as it only tends to emphasize any surface defects.

Basic flatness tolerances issued by the American Die Casting Institute specify a flatness variation of 0.003 in. on any dimension 3 in. long. An additional variation of 0.003 in. should be added for every inch over 3 in. These tolerances apply to all die casting alloys.

Threads

External threads can be economically produced on die castings, but their advantages and limitations have to be carefully weighed. Zinc alloys are more commonly threaded than any of the other alloys. Threads can be cast on aluminum and magnesium alloys but must be coarser and of larger diameter than zinc threads. For example, under ideal conditions a maximum of 32 threads per inch and a minimum thread o.d. of 3/16 in. is obtainable on zinc alloy threads. A maximum of 24 threads per in. and a minimum thread o.d. of ¼ in. can be obtained with aluminum and magnesium threads. In all cases threads require a light machining to remove the flash left by the forming die or slides.

Internal threads can also be die cast, but unless the casting is split, the core that forms the thread must be unscrewed from the casting, or the casting must be unscrewed from the core. Naturally, this is an expensive operation and can be particularly difficult if any sticking occurs because of shrinkage. For this reason, die cast internal threads are not usually specified in aluminum and magnesium castings, and are used in zinc castings only in special cases. In most designs it is easier to core out the hole and tap the thread.

Cores

Cores are indispensable in the manufacture of most die castings. Their usefulness stems from their ability to:

1. Save metal and lower costs.
2. Provide uniform sections.
3. Provide accurate holes and eliminate costly machine operations.
4. Provide design features not obtainable by any other production method.

Cores can provide holes, slots and recesses in a variety of shapes and sizes. Simple cylindrical cores should be used wherever possible to keep costs down. Complex cores are expensive to make; however, their cost may be justified if they eliminate machining operations on the casting.

Cores can be divided into two main types: fixed and moving. Fixed cores are permanently fixed to the die and their axes are parallel to the motion of the die and perpendicular to the die parting. Because of their simple construction, fixed cores are less expensive than moving cores.

Moving cores are required for any holes that must be placed at an angle to the motion of the die. They are moved into the die before the molten metal is injected, and are removed before the die is separated and the casting removed.

Naturally, cores must have sufficient rigidity to withstand the high pressures of the die casting process. Consequently, as shown in Table 5, practical limits have been established on their length-to-diameter ratio.

In order to permit removal of the casting from the die it is essential that all cores be tapered. As shown in Fig 2, the amount of draft required depends on the depth of the hole and the type of alloy used. These tolerances do not apply to cored holes that must be subsequently tapped. However, tolerances on cored holes for tapping are readily available from the American Die Casting Institute (ADCI-E8-55T).

Many different cores and coring techniques are available that can increase the complexity and utility of die castings.

Rotary cores have a curved shape and are pulled from the casting on an arc. Although they are expensive to make they often provide the only way of obtaining a curved internal cylindrical shape. In many applications (such as water valves and spouts) their cost is fully justified by the results obtained.

Collapsible cores can be used when an internal hollow cannot be made more cheaply by using loose die pieces or by machining. As their name implies, the cores are collapsed and removed before the casting is ejected from the die. They have proved advantageous in forming internal threads, but machining is usually required to remove the excess metal at points where the core sections meet.

Knockout cores can be used to pro-

TABLE 5—DEPTH OF CORED HOLES[a]

Alloy ↓	Diameter of Hole, in.								
	1/8	5/32	3/16	1/4	3/8	1/2	5/8	3/4	1
	Maximum Depth, in.								
Zinc	3/8	9/16	3/4	1	1 1/2	2	3 1/8	4 1/2	6
Aluminum[b]	5/16	1/2	5/8	1	1 1/2	2	3 1/8	4 1/2	6
Magnesium[b]	5/16	1/2	5/8	1	1 1/2	2	3 1/8	4 1/2	6
Copper[b]	—	—	—	1/2	1	1 1/4	2	3 1/2	5

[a]From American Die Casting Inst. Product Standard ADCI-E6-55T. Cored Holes: Optimum greatest depth of cored holes as related to diameter is shown in the table. The values shown are subject to the draft requirements shown in ADCI Product Standard E7. Requirements for tapped holes are shown in ADCI Product Standard E8.
Note: The values shown represent normal production practice at the most economical level. Greater depth involving extra close work or care in production should be specified only when and where necessary since additional cost may be involved.
Note: The depths shown are not applicable under conditions where small diameter cores are widely spaced and, by design, are subject to full shrinkage stress.
[b]For cores larger than 1 in. in diameter, the diameter-depth shall be 1:6.

vide undercuts or holes in designs where it is not possible to remove the core while the casting is still in the die. The cores remain in the casting and are not removed until the casting is ejected from the die. They are subsequently knocked out of the casting and can be reused. Naturally, this technique is expensive, but it may be the only way of obtaining the required design.

Intersecting cores are especially useful in forming interconnecting holes and passages.

Inserts

Inserts are extensively used in die castings to:

1. Improve the strength, hardness, wear resistance, ductility, flexibility and other properties of the die casting.
2. Provide a means of assembly.
3. Provide a passage or other shape which cannot be readily produced by coring or casting.
4. Simplify construction. In some cases when it is not possible to make a casting in one piece, one or more parts can be die cast separately and used as inserts around which the remaining structure is cast.

Naturally, inserts are expensive, but they are often cheap in the long run, and they can provide advantages not obtainable by any other production method.

Inserts can be applied either before or after casting. Cored holes or recesses must be provided to accommodate inserts applied after casting, and the inserts must be firmly anchored in place by knurling or staking. If any special machining is needed to accommodate an insert the designer should consider using an insert which is cast in place. Because of metal shrinkage, inserts cast in place are held quite rigidly, especially when they are provided with knurls, holes or grooves. Sufficient metal thickness should be provided around the insert to give it adequate support. Also, the insert should be designed so that the molten metal does not cover surfaces which are supposed to be uncovered.

A means must be provided for fastening a cast-in insert in the die before casting takes place. This can be done by setting parts of the insert which will not be exposed in the completed assembly into one or more holes in the die. It is best to locate the insert axially against a shoulder or in such a way that when the die closes the insert is prevented from moving. Of course, the insert must never be located in a way that it prevents the die from closing.

Electrolytic action can take place between the insert and the casting under corrosive conditions. Thus, it is good practice (though not always necessary) to electroplate steel inserts. Cadmium, tin or lead coatings should not be used on inserts for zinc die castings because of their unfavorable reaction with zinc. These coatings can, however, be used on the other die casting metals without ill effect. Coatings of zinc, nickel, chromium or copper can be used on inserts for all die casting metals with good results.

Undercuts

It is well known that undercuts tend to increase the cost of die castings and their dies. All unnecessary undercuts should be avoided. However, there are many cases where undercuts can save costs in the long run. Thus, a thorough cost analysis should be made when there is an option of using an undercut.

In many cases, undercuts can provide considerable savings in metal and/or eliminate subsequent machining operations. Undercuts can eliminate unwanted metal concentrations and promote uniform wall thicknesses.

Expensive slides and cores are usually required to produce undercuts. However, the fact that they are so frequently used points up the fact that their benefits clearly outweigh their disadvantages in many designs. Also, the product engineer should realize that there are various tricks and expedients for making undercuts, some of which are quite inexpensive.

Lettering

Letters, numbers, trademarks and other symbols can be easily and cheaply formed in die castings. Wherever possible, it is desirable that the letters be raised rather than depressed on the casting. The reason is that it is much easier and less expensive to machine depressed letters in the die. Also, because of their sharp edges, raised letters in a die have a tendency to deteriorate rapidly after continued exposure to molten metal under pressure.

The height of letters should not greatly exceed the width. A height-to-width ratio of 1.5 to 1 is considered good practice. Ordinarily, each leg of a letter should be at least 0.02 in. wide and should be raised at least 0.02 in. from the casting. A 10-deg taper is recommended for the walls of all letters.

Acknowledgments

The author would like to express his appreciation for the assistance of personnel and literature from the following organizations in preparing this article:

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Dow Chemical Co.
Eclipse-Pioneer Div., Bendix Aviation Corp.
Gries Reproducer Corp.
Litemetal Dicast, Inc.
Magnesium Assn.
Nelmor Mfg. Corp.
New Jersey Zinc Co.
Titan Metal Mfg. Co.

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first in silicones

Dow Corning

SILICONE NEWS

for design and development engineers • No. 67

HOW TO STOP TONS

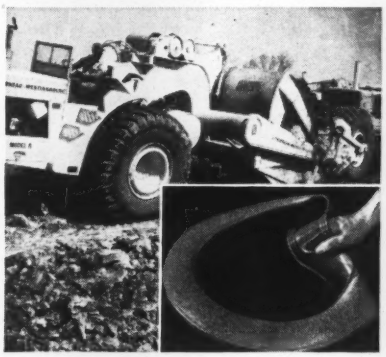
How to bring massive earth-moving machines to quick, positive stops time after time? That was the design problem. Le Tourneau-Westinghouse found the solution in using actuating-pressure brake diaphragms made of Silastic®, the Dow Corning silicone rubber.

Engineers estimate that rubber-tired giants like the 70-ton Tournapull expend five times more mechanical energy in coming to a stop from a speed of 30 mph than an automobile uses in coming to a stop from 80 mph. Brakes installed on all four wheels of these massive vehicles must absorb energy at the rate of 1700 BTU per second when making a quick stop.

Naturally, when this kind of energy is converted into heat a few successive times, temperatures inside the brake units rapidly rise past the boiling point . . . with intermittent highs in excess of 500 F.

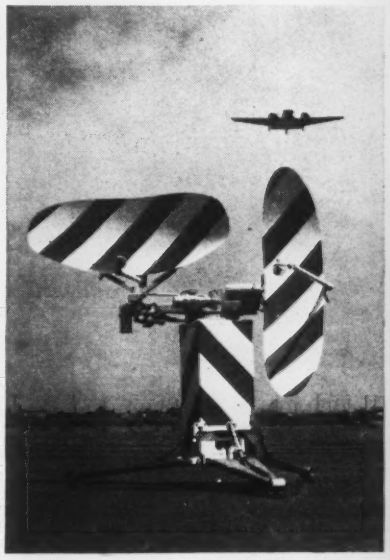
LeTourneau-Westinghouse assures reliable braking by utilizing Silastic coated, glass-cloth actuating pressure diaphragms. Placed in test service in March 1956, these silicone rubber diaphragms proved so successful the company standardized on Silastic for all its 20 to 70 ton machines.

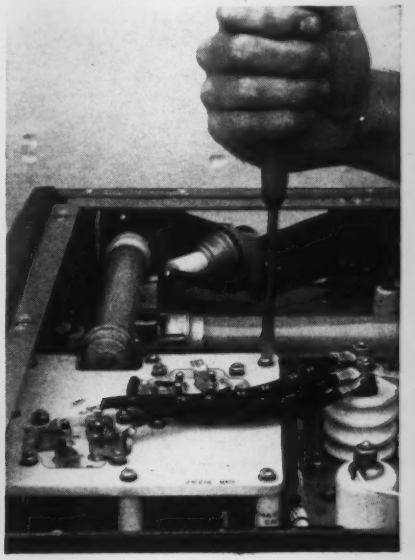
Yale Rubber Company, Sandusky, Mich., engineered the diaphragms which, under



test, have repeatedly withstood 100,000 half-inch flexings while intermittently exposed to temperatures in the range of 500 F, without loss of their original shape, strength or elasticity. Expectations of a 500% increase in the service life of the diaphragms have been fulfilled.

This is another instance where the unusual properties of Silastic have helped designers meet rigid performance requirements and increase service life. *No. 242*





SILICONES AID FLIGHT

Where top reliability is a must, you can depend on silicone-glass laminates. A case in point: the Quadradar navigational aid produced by Gilfillan Brothers, Inc., Los Angeles.

Quadradar provides vital flight information that facilitates ground controlled approach and landing of new, high-speed military and civilian aircraft. Now in world-wide use, this system consists of two units: a receiver-transmitter and an operating console. Its coverage gives altitude, azimuth, and range position on straight-in penetration approaches from 50,000 feet and 40 miles to touchdown. This enables the ground operator to effectively maintain surveillance and to guide jet craft to landing strip in minimum time.

To assure dependable uniform performance, whether operating in the Arctic or the tropics, Gilfillan engineers specified silicone-glass laminates. Safeguarding the system's dependability, silicone-glass laminates prevent recurring arcing under high voltage and high humidity conditions, have low moisture absorption, and provide low loss factor and low attenuation at RF frequencies. Made of glass cloth bonded with a Dow Corning silicone resin, these laminates retain excellent dielectric and mechanical properties even after long term aging at 250 C.

What's more, silicone-glass laminated parts are relatively unaffected by vibration. They are easy to fabricate and light in weight.

These are the reasons why Gilfillan engineers specify silicone-glass laminates with confidence wherever reliability is a major performance requirement. *No. 241*

New Tape Simplifies Processing

New Guideline triangular tape now makes possible silicone rubber electrical insulation systems at costs competitive with other form-wound coil insulation systems. The reason: processing economies resulting from the tape's unique triangular construction and self-adhering properties.

A Dow Corning development, Guideline tape made of Silastic® retains exceptional electrical and physical properties from —90 to 250C, resists arcing, ozone and corona. It produces a homogeneous resilient insulation system resistant to heat, cold, moisture, many chemicals and corrosive atmospheres.

(Cont. pg. 2)

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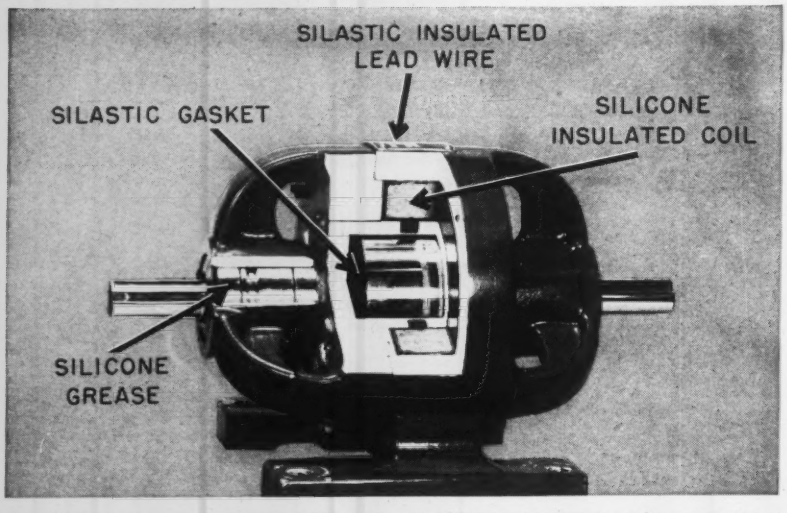

CLUTCH PLAYERS HELP TEAM WIN

Engineers frequently solve tough design problems "in a clutch" with silicones. An excellent demonstration of this is the successful operation of the magnetic clutch produced by Vickers Incorporated, Electric Products Division, Sperry Rand Corp., St. Louis, Mo.

By controlling torque through a magnetic-particle field, Vicker's Magneclutch assures smooth acceleration of rotating equipment without chatter or grab. Since the Magneclutch can slip continuously, the unit must dissipate the heat that is produced. It's not surprising, therefore, to find heat-resistant Dow Corning silicone products including coil insulation, lead wire, lubricants and mechanical gaskets playing an important role in the design.

One critical component requiring silicone protection is the excitation coil which produces the torque-controlling magnetic field. Insulated with silicone components and dipped in Dow Corning 997 Varnish, the coil will readily withstand temperatures far in excess of those permitted by other insulating materials. This silicone insulating system permits operating at temperatures of 180 C or better.

Lead wire to the excitation coil is insulated with Silastic®, the Dow Corning silicone rubber. Gaskets made from Silastic are used as seals between the end shield and outer rotating cylinder. Finally, nonoxidizing, nongumming silicone grease is used to lubricate the ball bearings.

How reliable is the finished unit? Field reports indicate that Magneclutch units require virtually no maintenance and easily last the life of the equipment to which they are applied. *No. 243*

SILASTIC TAPE *(Continued)*

Cost-saving advantages include:

One wrap only. A single wrap of Guideline triangular tape of suitable thickness is all that's needed to produce the entire primary insulation wall thickness.

Self-adhering. The tape bonds to itself . . . requires no pasting. What's more, the tape's beveled edges overlap smoothly . . . produce a void-free insulation structure.

Easy to apply. A conspicuous center line makes it easy to achieve a precise half-lap construction of uniform thickness.

Insulation systems made of Silastic permit use of open motor frames in contaminated areas where totally enclosed motors might otherwise be required. For full information plus a list of companies producing insulating materials made from this silicone rubber, circle ..... *No. 244*

new literature and technical data on silicones

Tapes That Stick — Dow Corning silicone pressure sensitive adhesives make tapes stick to anything. They help achieve serviceability over a wide range of temperatures, resistance to oxidation, weathering, corrosive chemicals, and retention of good dielectric properties. For information on the properties of tapes made with Dow Corning silicone adhesives, and their applications, circle . . . . . *No. 245*

What To Expect in the fuel, oil, and solvent resistance of several Silastic® stocks is the subject of a recently published data sheet. This three-page bulletin discusses factors affecting various types of silicone rubber including temperature, duration of exposure, swelling and softening, and contains a comprehensive table of chemical and oil resistance ratings of various types of silicone rubber. *No. 246*

New Dielectric Gel — Now available — a new silicone potting material that permits visual and instrument checking of electronic assemblies and has good thermal stability, low mechanical stress, and physical stability. Convenient to use, it pours like a liquid, then gels into a crystal clear, self healing dielectric that cushions and protects against vibration, shock, moisture, dirt and dust. A new illustrated brochure contains a table of properties and facts you'll want to consider about Dow Corning Dielectric Gel. *No. 247*

Syl-off Sources — A complete listing of approved producers of paper and paper products coated with Syl-off is now available. Listing includes producers of just about every kind of paper that will provide quick, easy and inexpensive release . . . kraft, glassine, parchment, multiwall bags, tissue, asphalt packaging containers and board, food grade coated papers. *No. 248*

You Can Provide up to 100% longer surface protection if you specify silicone-based paints for the domestic appliances and the industrial equipment you design. A unique, full page graph in a 4-page brochure will help you choose the type of paint best suited for every application. A separate listing of producers of silicone paints is included. *No. 249*

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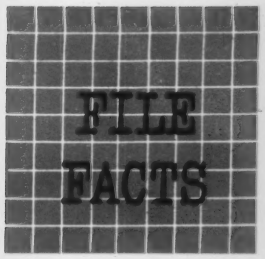


Titanium Mill Products: Designations and Availability

(Commercial and Semicommercial)

Nominal Composition, Wt %	Standard Designations			Producers' Designations				Mill Forms[a]
	AMS	ASTM	Military	Crucible	Mallory-Sharon	Republic	TMCA	
UNALLOYED TITANIUM								
High Purity (99.9%)[b]	—	—	—	—	—	—	—	—
Commercial Purity (99.2%)	4902	B265-58T-Gr2	T-9047B-1	A-40	MST-40	RS-40	Ti-55A[c]	a, b, c, d, e, f, g, h
Commercial Purity (99.0%)	4900A	B265-58T-Gr3	T-9047B-1	A-55	MST-55	RS-55	Ti-65A	a, b, c, d, e, f, g, h
Commercial Purity (99.0%)	4901B, 4921	B265-58T-Gr4	T-9047B-1	A-70	MST-70	RS-70	Ti 75A, Ti-100A	a, b, c, d, e, f, g, h
ALPHA TITANIUM ALLOYS								
Ti-5 Al-2.5 Sn	4926	B265-58T-Gr6	T-9047B-2, T-9046B-3	A-110AT	MST-5 Al-2.5 Sn	RS-110C	Ti-5 Al-2.5 Sn	a, b, c, d, e, f, g, h
Ti-6 Al-4 Zr-1 V	—	—	—	—	—	—	Ti-6 Al-4 Zr-1 V	c, d
Ti-8 Al-1 Mo-1 V	—	—	—	—	—	—	Ti-8 Al-I Mo-1 V	a, b, d
Ti-8 Al-2 Cb-1 Ta	—	—	—	—	MST-821	—	—	a, b, c, d, g
Ti-8 Al-8 Zr-1(Cb + Ta)	—	—	—	—	MST-881	—	—	a, b
Ti-Zr-Al[d]	—	—	—	A-120ZA	—	—	—	a, b
ALPHA-BETA TITANIUM ALLOYS								
Ti-3 Al-2.5 V	—	—	—	—	MST-3 Al-2.5 V	—	—	e, f
Ti-5 Cr-3 Al	4927	—	T-9047B-3	—	MST-3 Al-5 Cr	—	—	a, b, c
Ti-2 Fe-2 Cr-2 Mo	4923	—	T-9046B-4, T-9047B-4	—	—	—	Ti-140A	a, b, d, e, f
Ti-8 Mn	4908A	B265-58T-Gr7	T-9046B-1	C-110M	MST-8 Mn	RS-110A	—	c, d, e
Ti-4 Al-4 Mn	4925A	—	T-9047B-6	C-130AM	MST-4 Al-4 Mn	RS-130	—	a, b, c, g
Ti-4 Al-3 Mo-1 V	—	—	—	C-115AMoV	—	RS-115	Ti-4 Al-3 Mo-1 V	c, d
Ti-4 Al-4 Mo-4 V	—	—	—	—	—	—	Ti-4 Al-4 Mo-4 V	a
Ti-5 Al-2.75 Cr-1.25 Fe	—	—	—	—	—	RS-140	—	a, b, c, d
Ti-5 Al-1.5 Fe-1.4 Cr-1.2 Mo	4929	—	T-9047B-7	—	—	—	Ti-155A	a, b, c
Ti-6 Al-4 V	4911, 4928	B265-58T-Gr5	T-9046B-2, T-9047B-5	C-120AV	MST-6 Al-4 V	RS-120A	Ti-6 Al-4 V	a, b, c, d, e, f, g, h
Ti-7 Al-4 Mo	—	—	—	C-135AMo	—	RS-135	Ti-7 Al-4 Mo	a, b, g, h
Ti-16 V-2.5 Al	—	—	—	C-105VA	MST-16 V-2.5 Al	—	—	a, b, c, d, e, g
BETA TITANIUM ALLOYS								
Ti-13 V-11 Cr-3 Al	—	—	—	B-120VCA	—	RS-120B	Ti-13 V-11 Cr-3 Al	a, b, c, d, e, g

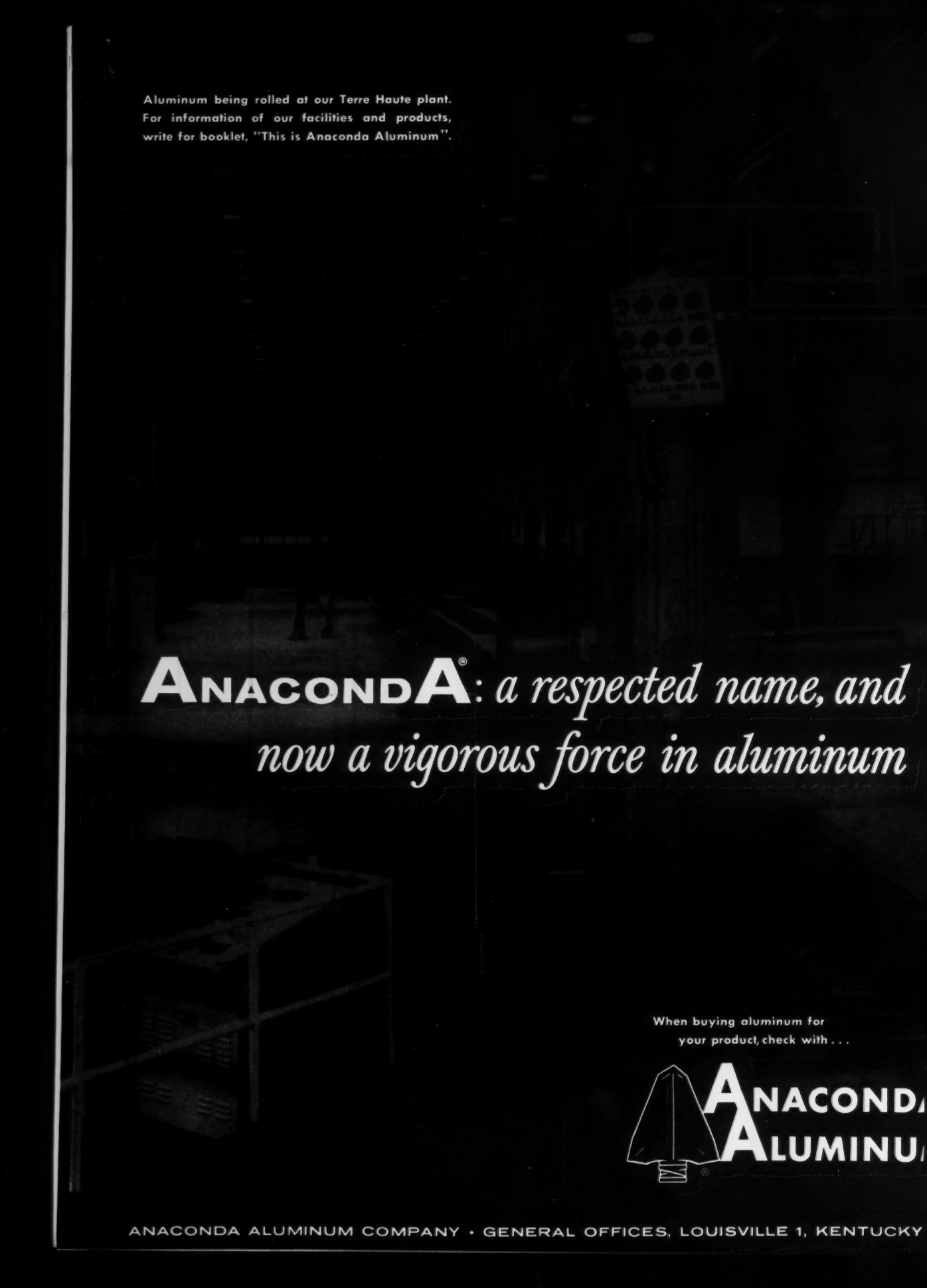
[a] *a*, bar; *b*, billet; *c*, plate; *d*, sheet; *e*, strip; *f*, tubing; *g*, wire; *h*, extrusions. Note: Specifications do not cover all mill forms.

[b] This classification includes iodide process crystal bar and products from newer processes such as electrolysis of fused salt baths. Among producers recognized in the field from whom material may be available on a limited basis are National Distillers, Bureau of Mines, New Jersey Zinc, and Foote Mineral.

[c] Softer grades designated Ti-35A (35,000 psi yield strength) and Ti-45A (45,000 psi yield strength) also available.

[d] Composition not final; formerly RC 900 (Ti-12 Zr-4.5 Al).

Courtesy Defense Metals Information Center, Battelle Memorial Inst., Apr '59.



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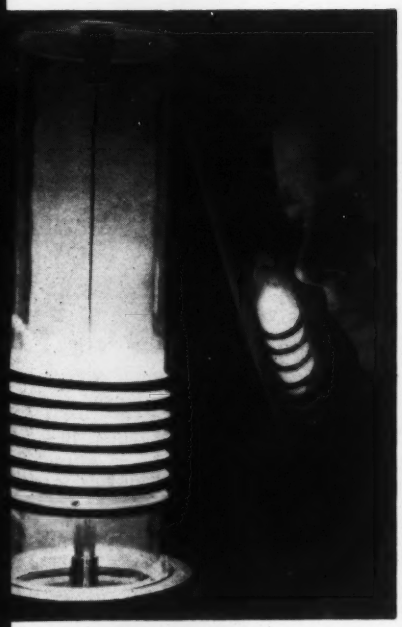


Germanium dendrites *rise out of molten pool in this crystal growing furnace.*

Germanium Crystals Grown Ready for Immediate Use

■ Scientists at Westinghouse Electric Corp.'s research laboratories, Box 2278, Pittsburgh 30 have developed a new method for growing germanium crystals. The method is said to grow thin, flat strips, or dendrites, of germanium in the exact form in which they are used in electronic devices.

Details as to how the germanium is grown have not been revealed.

S. W. Herwald, vice president-research, says the germanium growing technique appears to be feasible for the automatic production of transistors and other solid state devices directly by machine.

Potential applications

Research to date shows that the new growing technique may lead to the development of outer space electronic equipment 1000 times smaller and lighter than anything now in existence.

For example, germanium crystals grown by the technique have reduced the weight of a telemetry subsystem from its present 7 gm to 0.02 gm. The number of parts was cut from 14 to 1 and soldered connections from 15 to 2.

Other studies are currently being conducted on the use of dendritic germanium crystals in infrared, reconnaissance, flight control and communications equipment.

Processing

According to Westinghouse scientists, dendritic germanium is of the proper thickness for direct use and requires no cutting, grinding or polishing of any kind.

In contrast, conventional germanium crystals must first be cut with a diamond-tipped saw into wafers. These wafers must be three to five times the desired thickness to keep them from shattering during processing. The wafers are then ground to the required thickness, further cut into

Automatic transistor production: *1) devices are formed as a continuous series of dots along the long, thin, flat surface of the germanium crystal; 2) electrical connections are made to the dots, after which they are separated from the germanium strip; 3) the unit is placed in a container.*

For more information, circle No. 364

small squares, and finally polished. Only then is the germanium ready to be fashioned into finished transistors or other devices. As a result of all this cutting and polishing, about 80% of the original ingot is thrown away as germanium "sawdust."

'Molecular electronics'

The development of working electronic devices from germanium dendrites is being carried out under a $2 million "molecular electronics" contract recently awarded to Westinghouse by the Air Force.

The molecular electronics concept involves a new understanding of the basic nature and capabilities of materials, and a new approach—on a molecular and atomic scale—to the conception, design and development of materials.

"In molecular electronics one seeks to combine several separate electronic functions into a single operating unit that duplicates their overall electrical behavior," Herwald explained. "For example, one can conceive of a single tiny slab of solid material that performs the function of a combination of transistors, resistors, capacitors, plus other circuit components, and yet contains none of these components as actual entities in an electronic device."

What's new IN MATERIALS

Butyl Rubber Cures Fast, Resists Heat, Ozone, Chemicals

■ A new, fast curing butyl rubber is now available in pilot plant quantities at a price of 35¢ per lb. Full scale production is expected in early 1960, with the price scheduled to go down to 30¢ per lb. The material, first announced in the spring of 1958 (see M/DE, May '58, p 3), was developed by affiliates of the Enjay Co., Inc., which will market the product. Enjay's headquarters are located at 15 W. 51st St., New York 19.

The synthetic rubber, a chlorine-containing polymer, is said to have good resistance to heat, chemicals, oxidation and ozone. It also has low compression set, good compression flexing, low permeability to gases, and good tear strength. The rubber, called MD-551, is compatible with most other elastomers, such as butyl, natural rubber, SBR and neoprene.

Potential uses

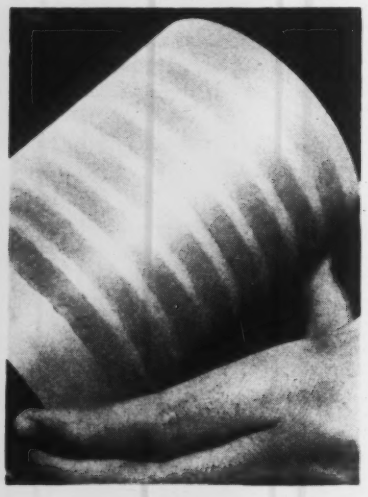
R. E. Clayton, J. V. Fusco and L. T. Eby of Enjay's Market Development Div. pointed out at a recent meeting of the Chemical Institute of Canada that MD-551 can be compounded with nontoxic accelerators for use in the food industry. Typical products would be collapsible rubber tank containers, tubing for dispensing milk, flavors, etc., beer hose and conveyor belts. Other applications outside of the food industry might be seals, gaskets, spark plug caps, brake boots, vibration dampers, conveyor belts, steam hose and inner liners for tires.

Properties

Tensile strength — Room temperature tensile strength of MD-551 is 2400 psi. According to the developer, vulcanization systems based on zinc oxide alone, or preferably augmented with common vulcanization accelerators, give high tensile strengths with sufficient extension prior to rupture.

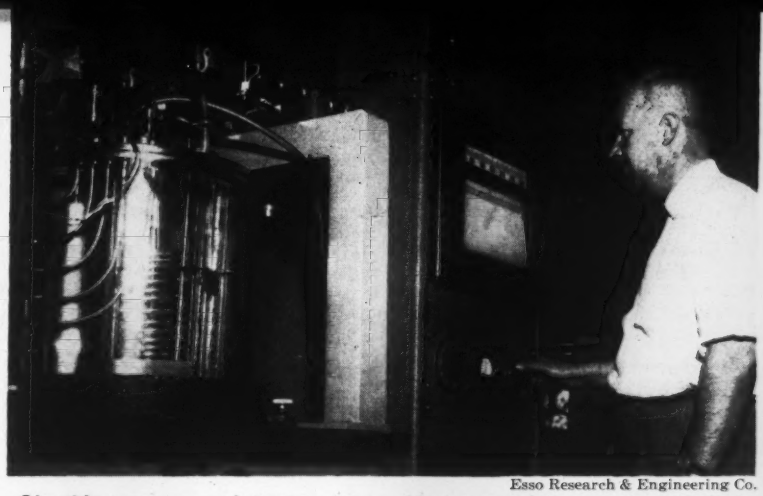
Heat resistance—Non-sulfur vulcanizates appear to have better tensile strengths after aging 72 hr at 300 F than do sulfur vulcanizates.

Ozone resistance—Chlorine-containing butyl rubber specimens with various cure systems showed excellent resistance to ozone. Particularly outstanding were the amine and methylol phenol resin



New aluminum welding alloys—Shown here is an aluminum diesel engine piston whose grooves are welded with hard and wear resistant aluminum welding alloys. The alloys (four are now being tested) were developed by Aluminum Co. of America, 1501 Alcoa Bldg., Pittsburg 19. In addition to pistons, the alloys are also expected to be used on brake drums, valve seats and sheaves.

One of the alloys is said to provide a hardness of 250 Bhn at room temperature. Currently used aluminum welding alloys generally provide a hardness of 110 Bhn at room temperature, Alcoa says. Welds from the new alloys are reported to be four times as hard as welds made from conventional alloys at 500 F.



Esso Research & Engineering Co.

Checking ozone resistance *of new chlorine-containing butyl. The device enables the technician to detect and measure cracks in the rubber before they can be seen with the naked eye.*

cures. Specimens were evaluated in an 0.2% ozone atmosphere at 50% elongation.

Compression set—The fast cure rate and good stability of cross-links are said to contribute to the outstanding compression set properties possible with MD-551 vulcanizates. A compound with a methylol phenol resin cure gives compression set values of 20% and less after aging 70 hr at 212 F.

Gas permeability—MD-551 is said to have gas permeability properties similar to those of polyisobutylene and butyl rubber. This is understandable since the hydrocarbon portion of the polymer is largely polyisobutylene.

Processing

The chlorine-containing butyl can be mixed on conventional rubber compounding mills or in internal mixers. It can be extruded and calendered much in the same way as butyl rubber.

PROPERTIES OF MD-551[a]

Tensile Strength, psi	
Room Temperature	2400
300 F[b]	1200
Elongation, %	
Room Temperature	300
300 F[b]	250
Tear Strength, lb/in.	190

[a]Tests performed on specimens cured with methylol phenol resin.
[b]Aged 72 hr.

MD-551: What It Is

Enjay's new rubber is a chlorine-containing isobutylene-multiolefin copolymer. Chlorine content is about 1.1 to 1.3%. Unsaturation is between 1 and 2 mole %. Viscosity average molecular weight is about 450,000. The rubber has an amber color and a specific gravity of 0.92. The raw polymer is completely soluble in hydrocarbon solvents showing no gel. The material may be cured through its unsaturation and its active chloride.

Designed for service at –320 F

9% Nickel Steel Is Strong, Weldable, Easily Formed

by William H. Funk
Research Administrator, Lukens Steel Co.

■ New information is now available on properties, weldability and uses of a 9% nickel steel introduced two years ago.

The steel, a low carbon, high nickel plate material, was developed by Lukens Steel Co. in cooperation with International Nickel Co. and is available from Lukens in the form of plate and formed heads.

Properties

Major advantages of the steel are: good strength at low weight (it is about 25% stronger than type 304 stainless steel), low cost (about half that of 304), ease of

Segments *of 9% nickel steel are easily welded into huge spherical vessel.*

fabrication, and ability to maintain good weld strength at low temperatures. Tensile properties and Charpy impact values are given in the tables on page 136.

Perhaps the major advantage offered by 9% nickel steel is its good weldability. At –320 F, most conventional materials (such as carbon steel) behave poorly, and welds produced by conventional electrodes are susceptible to brittle fracture. Early attempts to weld 9% nickel steel, using 25-20 stainless steel electrodes, were not too successful. Now, however, high nickel-chromium-iron electrodes (Inco A) produce welded joints with strengths higher than the minimum specifications for the steel itself (see table). According to Lukens, the steel can be welded either by the consumable electrode, inert-gas-shielded technique or by the manual metallic arc method.

The weld joint data presented in the accompanying tables were obtained by procedures in accordance with ASTM A-353-54T as required in the ASME Unfired Pressure Vessel Code. Some work now being done, however, indicates that post-welding stress relief may not be necessary to obtain good weld joint properties.

TENSILE PROPERTIES OF 9% NICKEL STEEL

Form →	1-In. Test Plate[a]	Welded Joint[b]
Ten Str, 1000 psi	90	106.5
Yld Str (0.2% offset), 1000 psi	60	76.4
Elong (in 2 in.), %	22	14
Red. of Area, %	—	40

[a]Double normalized at 1650 and 1450 F, stress relieved 2 hr at 1050 F.
[b]Inco A electrodes; 15 passes to fill joint; root back-ground to ½-in. depth, ¾-in. width; 9 more passes.

V-NOTCH CHARPY IMPACT VALUES OF WELDED 9% NICKEL STEEL (Ft-Lb)

Temp ↓	Base Metal[a]	Heat Affected Zone	Weld Metal
Rm Temp.	85-90	103-200	74-92
0 F	81-97	90-114	80-86
–130 F	75-80	90-122	76-84
–320 F	18-25	75-100+ (did not break)	70-77

[a]Transverse.

COMPOSITION OF 9% NICKEL STEEL (%)

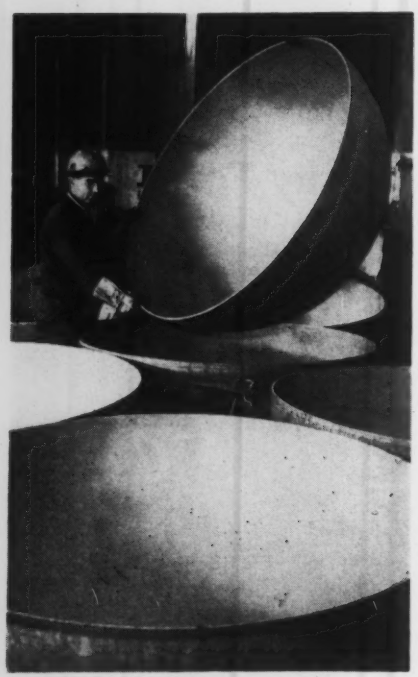
Element ↓	Test Plate	ASTM Spec A353
Carbon	0.09	0.13 max
Manganese	0.47	0.80 max
Phosphorus	0.011	0.035 max
Sulfur	0.021	0.040 max
Silicon	0.021	0.15-0.30
Nickel	8.93	8.50-9.50

Applications

The 9% nickel steel was developed primarily to satisfy a need for an inexpensive plate material for pressure vessel applications at very low temperatures (–320 F). Its largest field of application at present is containers used to house and dispense liquid oxygen and nitrogen. According to Lukens, many users are switching from compressed to liquid oxygen and nitrogen to save on storage space and to eliminate certain hazards and expensive handling problems.

Specific applications include vessels for missile fuel storage, steelmaking, welding, flame cutting, and various uses in the chemical, petroleum, paper and other process industries.

(more What's New on p 139)



***Cryogenic vessels** for storage of liquid oxygen are fabricated from these hemispheres of 9% nickel steel.*

MORE WHAT'S NEW IN MATERIALS

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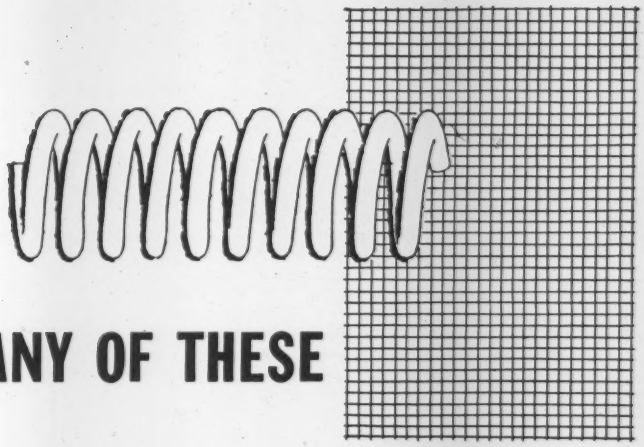
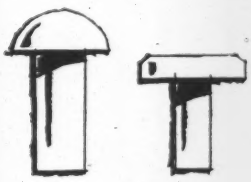


IF YOU MAKE ANY OF THESE



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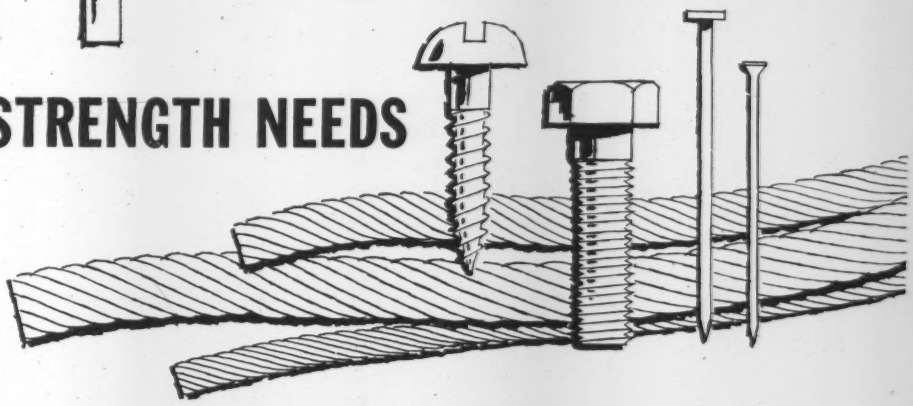

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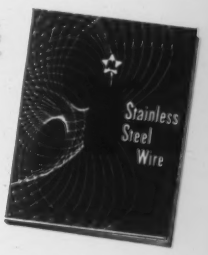
Write for your copy of Allegheny Stainless Wire, Illustrated 20-page booklet, which fully describes analyses, physical properties, corrosion resistance and principal applications of stainless wire.



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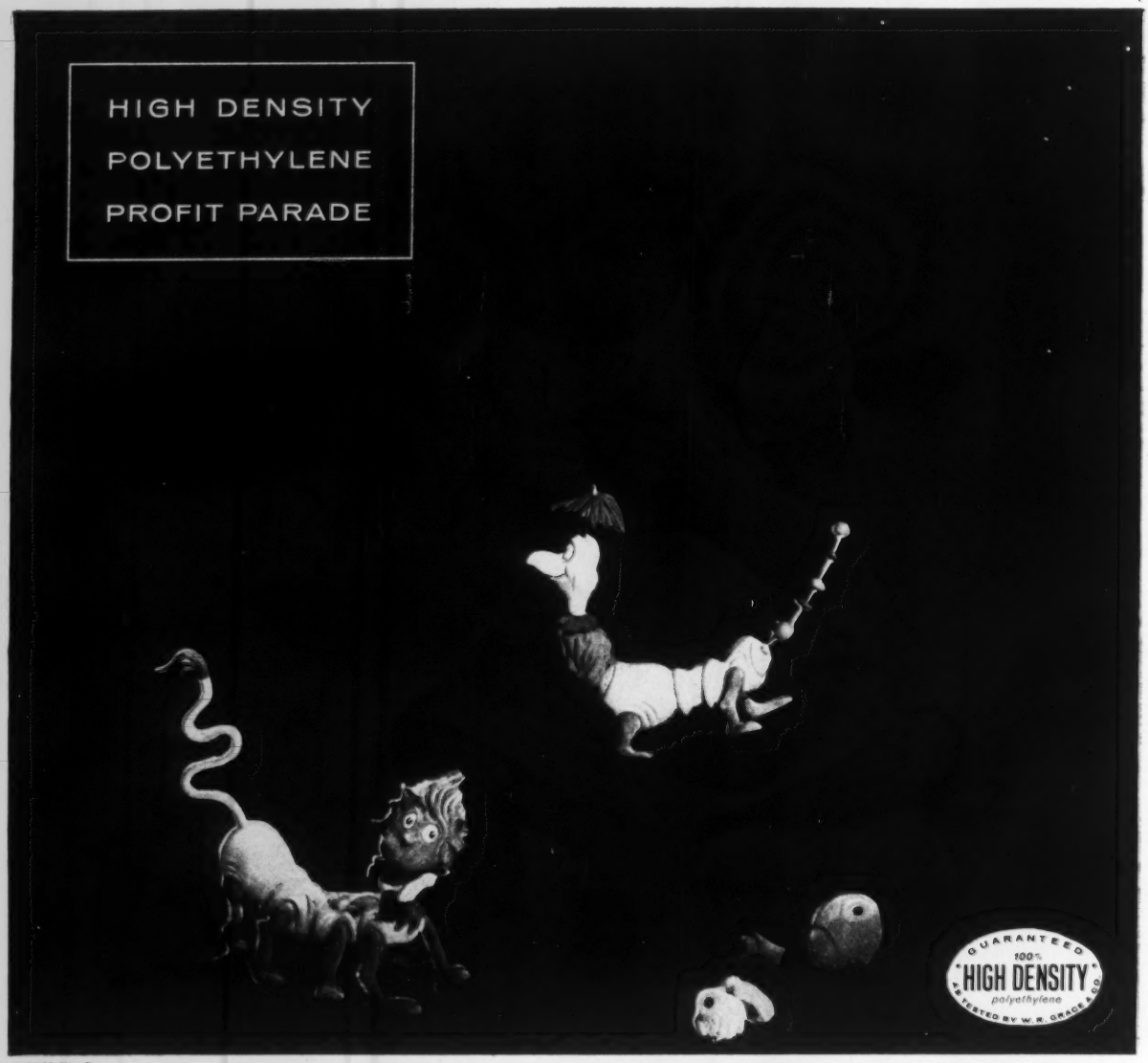

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Play-proof Properties Spark New Product Idea

Developing a new product? Grex high density polyethylene could stir up as much excitement for you as it's doing for Revell, Inc. Their new product combines the toughness of Grex with the appeal of fantastic animal characters that roam the pages of Dr. Seuss' juvenile books. Sold in kits of interchangeable parts, Dr. Seuss Zoo inhabitants snap together and pull apart in millions of ways—are colorful and strong enough to take the roughest treatment without breaking, chipping or cracking.

There is virtually no limit to profitable new product applications with this versatile Grace plastic. Here are just a few of its advantages: It can be fabricated at low cost and molded in any color. It is a hard, stiff, rugged thermoplastic that takes boiling or freezing without losing its shape or strength.

Find out more about high density polyethylene for the new product you have in mind by calling in the experts. Grace has the production facilities, technical service and experience to help put your product in the Grex profit parade. We're easy to do business with.

Grex is the trademark for W. R. Grace & Co.'s Polyolefins.

W.R. GRACE & CO.
POLYMER CHEMICALS DIVISION
CLIFTON, NEW JERSEY

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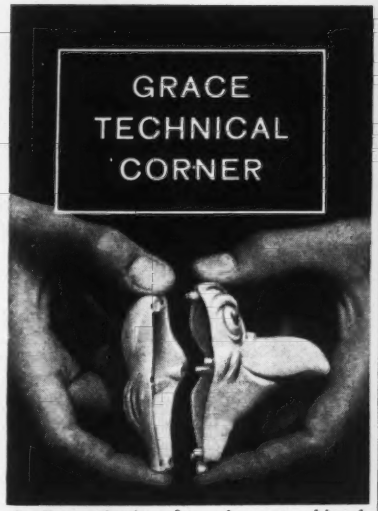


Quality production of complex parts achieved with fast cycles by specifying Grex.

Here you see 2 of 19 parts that make up Gowdy the Dowdy Grackle. Note their detail, irregularity of contour and how they snap together. In addition to Gowdy, Revell markets three other Dr. Seuss characters that are equally complex. The use of Grex high density polyethylene and substantial technical assistance from Grace helped Revell solve design and molding problems for this project. You can expect the same kind of benefits by working with Grace.

Design requirements of these Revell toys called for rigid parts with high impact strength. Resiliency was also needed to make snap plugs or poppets practical devices for snapping the parts together firmly and pulling them apart easily. Grex combines all three properties required—rigidity, high impact strength and resiliency. And the fact that the most intricate details can be molded with Grace's plastic provided freedom in reproducing these fantastic characters in three-dimensional shapes as suggested in Dr. Seuss books.

Mold layout and production. Revell's two molds for Dr. Seuss toys are among the most complicated ever used with Grex. They contain over 60 cavities; each cavity has an irregular parting line and many have serious undercuts. Stripping the parts from molds like these would have been either too slow for economical production or completely impossible with other plastics. High density polyethylene, however, solidifies in the mold at a high temperature yet remains flexible for stripping at fast cycles. Production efficiency was increased by using beryllium copper in many cavities and cores for effective heat removal.

Interested? If you have a job for high density polyethylene count on Grace for help. Now's the time to contact:

Technical Service Department,
W. R. Grace & Co., Clifton, N. J.

One-Coat Porcelain Competes with Paint

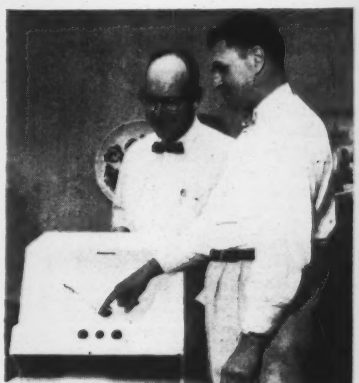
One-coat white porcelain enamels for non-premium steels are now available for commercial production. The one-coat system, called the "white direct-on" process, is expected to expand the use of porcelain on many products that for economic reasons have been finished with paint and other coatings. The one-coat enamel was developed by Ferro Corp., 4150 E. 56th St., Cleveland 5, Ohio.

One-coat enamels are not new. They have been used in a number of applications with varying degrees of success. However, Ferro's development appears to be the first one-coat enamel available in commercial quantities.

The white direct-on process appears to be the outgrowth of the so-called Ferro-Republic process which has been under development for several years (see *Materials & Methods*, Jan '56, p 94).

Quality is not sacrificed

According to Ferro, the quality of one-coat porcelain enamel finishes is as good as that produced by two-coat systems. In fact, the company says the white direct-on coatings are tougher and have better resistance to flexing and handling than two-coat enamels because of their decreased thickness. The one-coat enamels measure 3.5 mils minimum thickness compared to the 7-mil



***Steel sanitary ware** is a potential use for the direct-on metal treating process.*

STRAITS TIN REPORT

News of developments in the production and uses of tin

MALAYAN TIN BUREAU

New "cartridge-type" alloy bearings of tin, copper, lead and zinc will soon go into service on freight cars after 2 years of tests on U.S. railroads. Life expectancy of new bearing is said to be 25 years—compared to 3½ years for conventional bearings. It will require only minimum maintenance.

Greater creep resistance—that is the quality imparted to titanium with the addition of tin. Some titanium alloys contain as much as 22.5% tin. The most successful contains 2.5% tin and 5% aluminum. It is principally used for jet aircraft parts requiring maximum strength in the range of 600-1100°F.; in high-strength welded assemblies; and in jet engine combustion chamber casing and other uses requiring a better combination of toughness, fatigue strength, and creep resistance at elevated temperatures.

Electrodeposited coatings of tin-zinc have aided in solving auto fuel system problems caused by corrosive action of some fuels on carburetor parts.

A tin-cadmium alloy coating, according to research reports, has excellent resistance to salt spray, jet fuels, high temperature synthetic oils, organic acid vapors; very little embrittling effect on hardened steel.

Write today for more data on these items or for a free subscription to TIN NEWS—a monthly bulletin on tin supply, prices and new uses.

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minimum thickness of two-coat enamels.

Research efforts

Much research has been devoted to finding a way of applying a single coat of porcelain enamel to ferrous metals without the use of a ground coat. Hitherto, nearly all porcelain enameled surfaces required the application and firing of an opaque, blue cobalt ground coat to a special enameling grade of steel before the cover coat could be applied.

In general, the problem has been approached in three different ways: 1) special enamel formulations, 2) special surface preparation, and 3) special enameling steels. (For more information on special one-coat porcelain enamels, see M/DE, July '58, p 109.)

How coatings are applied

The Ferro process utilizes special surface preparation. Cold rolled steel is cleaned in an alkaline solution, rinsed, and annealed at 1200 F. The metal is then etched in an acid bath. Following etching, an 0.8-gm per sq ft coating of nickel is applied to the metal by a chemical reduction method. After rinsing and drying, porcelain is applied in the form of a thick, creamy slip. This is followed by drying and firing at 1450-1550 F.

The company expects that the white direct-on metal treating process will also be used to apply superior, two-coat porcelain enamel finishes to architectural panels and sanitary ware. It says, furthermore, that ground coats will continue to be used in certain applications such as the blue interior of laundry equipment, range ovens and hot water heaters.

Tungsten Carbides Resist Wear, Corrosion

Two new tungsten carbide compositions—a binderless carbide of tantalum and tungsten (called K601) and a tungsten carbide with a chromium-cobalt binder (called K701)—are now available for corrosion and wear parts made by Kennametal Inc., Latrobe, Pa.

K601 is relatively free of voids and provides good corrosion resistance in many applications where

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AMSCO ALLOY DESIGNATION	DESCRIPTION AND USES	MECHANICAL PROPERTIES
MY	Heat-treated, chromium alloyed manganese steel... for use in light-to-medium weight castings requiring modest improvement in growth and distortion, and increased stiffness.	tensile strength ..... 120,000 psi yield strength ..... 56,000 psi elongation ..... 45% reduction of area 30%
MML	Heat-treated, molybdenum alloyed manganese steel... for castings requiring improved weldability, for extremely heavy metal sections, and castings exposed to excessive heating environments.	tensile strength ..... 120,000 psi yield strength ..... 52,000 psi elongation ..... 50% reduction of area 40%
MMH	Heat-treated, molybdenum alloyed manganese steel... for use in castings requiring optimum mechanical properties and wear resistance. Provides improved stiffness and resistance to peening and flow.	tensile strength ..... 120,000 psi yield strength ..... 65,000 psi elongation ..... 20% reduction of area 18%
CML	Heat-treated, air-hardening chrome-moly steel... for casting applications involving scouring or grinding wear. Suitable for more complex casting designs.	tensile strength ..... 155,000 psi yield strength ..... 130,000 psi elongation ..... 10% reduction of area ..... 15% hardness ..... 275-375 BHN
CMH	Heat-treated, air-hardening chrome-moly steel... exhibits potentially improved wear resistance over CML (above), when shock loading is not sufficiently severe to cause breakage.	tensile strength ..... 155,000 psi yield strength ..... 130,000 psi elongation ..... 6% reduction of area ..... 7% hardness ..... 300-400 BHN
CS	Martensitic, multiple alloy steel with chromium, nickel and molybdenum... combines high mechanical strength with good abrasion and wear resistance.	tensile strength ..... 220,000 psi yield strength ..... 195,000 psi elongation ..... 8% reduction of area ..... 20% hardness ..... 300-500 BHN
HC	High chromium cast iron... provides outstanding abrasive wear resistance, where impact force is low but particle velocity and scouring forces are high.	tensile strength ..... 60,000 psi transverse strength ..... 7,000 lbs. deflection ..... 0.12 in. hardness ..... 400-600 BHN

For further information
—write for technical bulletin on "Amsco Ferrous Alloy Castings".

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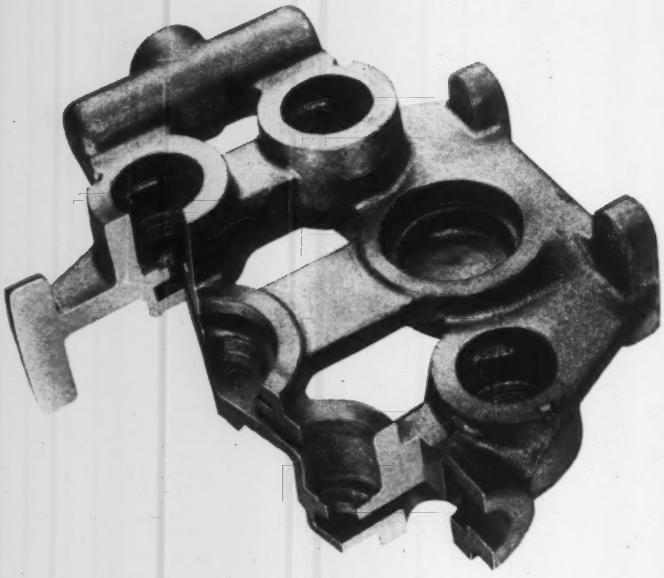

CAUSTIC SOLUTION

A CASE IN POINT—This is a 19 pound Ni-Resist valve body designed to handle caustic fluids at 400 psi. It was cast for the John Bean Division of Food Machinery & Chemical Corp. Ni-Resist is ideal for this application because it combines high corrosion resistance with superior resistance to erosion from high velocity fluids.

The intricate coring required demands unusual skill to produce Ni-Resist castings leak-proof at 400 psi operating pressures. Hamilton Foundry succeeded in producing pressure tight castings, an accomplishment difficult for the best of foundry men.

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PROPERTIES OF TUNGSTEN CARBIDES

Type ➡	K601	K701
Density, lb/cu ft	0.55	0.51
Coef of Ther Exp, per °F	3.4×10^{-6}	3.9×10^{-6}
Elec Cond, % IACS	5.35	—
Mod of Elast, psi	84.5×10^6	71.0×10^6
Hardness (Rockwell)	A94	A93
Compr Str, 1000 psi	675	677
Trans Rupture Str, 1000 psi	100	150

maximum corrosion resistance is not required. The material is nonmagnetic and can be used as wear parts in magnetic and video tape applications. The new carbide has been used successfully in seal ring applications, and is presently being tested in ball and seat valves and in compacting dies.

K701 is said to have excellent wear resistance in applications where severe corrosion is not a problem. However, corrosion resistance of the material is said to be better than that of conventional carbides. Cost of the material, although not revealed, is said to be less than that of K601. The new material is being evaluated in nozzles, compacting dies, ball and seat valves, and wear parts for coal processing machinery.

Strength of Ceramics at High Temperatures

What factors affect the strength of ceramic materials at high temperatures?

Plastic deformation is certainly one factor, say J. B. Wachtman, Jr. and L. H. Maxwell of the National Bureau of Standards. The two scientists recently studied the strength of aluminum oxide single crystals (sapphire and ruby) at temperatures between 1100 and 1800 F.

Study supports theory

Their study supports the theory that plastic deformation relieves stress concentrations in properly oriented crystals at temperatures above 1100 F, thus increasing crystal strength. Specifically, failure may be-

Details of the study may be found in Technical Report 2321, available from the National Bureau of Standards Office of Technical Information, Washington 25, D. C.

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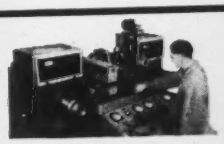
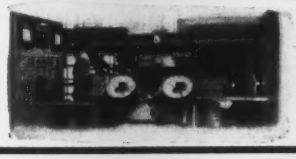


Wilbur B. Driver Company's Sendzimir Mills produce high accuracy in rolling



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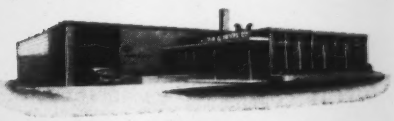
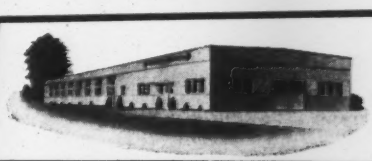


Cleveland warehouse is a typical WBD regional headquarters



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casting alloy

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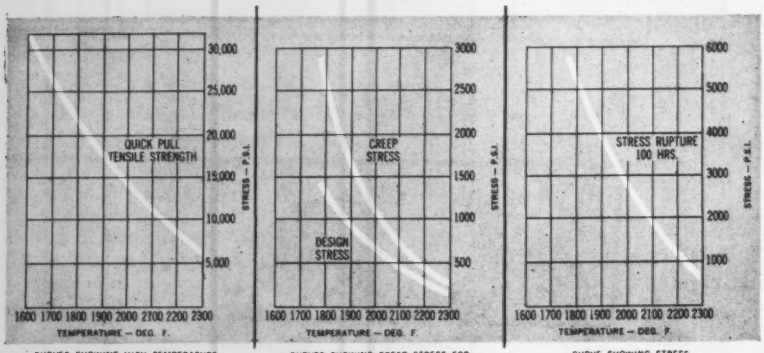

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gin at points where the local stress is much greater than the average applied stress. Plastic deformation then reduces the degree of stress concentration with the result that a larger average stress is sustained before failure occurs.

To test this hypothesis, both sapphire and ruby crystals were oriented (45 deg) for plastic deformation, and modulus of rupture was measured on the crystals at various temperatures up to 1800 F. For comparison, like studies were made on unfavorably oriented (0 deg) sapphire. Tests were performed in vacuum and in inert and oxidizing atmospheres with a controlled loading rate.

Test results

Data from the study show 1) a large increase in strength for both 45 deg sapphire and 45 deg ruby at temperatures above 1100 F, and 2) a large scatter in strength values for sapphire and ruby at temperatures below 1100 F.

Polycrystalline aluminum oxide, in contrast to single crystal aluminum oxide, decreases in strength at temperatures above 1400 F. This decrease in strength of polycrystalline aluminum oxide is thought to result from stress concentrations caused by grain boundary slip.

Temperature Control in Spacecraft Materials

One of the formidable and intriguing problems confronting space scientists is how to keep space vehicles from becoming too hot or too cold for their delicate instruments to operate or for human passengers to survive.

This problem was explored by 200 of the nation's top scientists at a recent symposium cosponsored by the Air Research and Development Command of the U. S. Air Force and the Missiles and Space Div. of Lockheed Aircraft Corp., Sunnyvale, Calif. The symposium was the first technical meeting devoted entirely to the subject of thermal design and

The proceedings of the symposium are now being edited for publication in book form. The book is expected to be published late in 1959.

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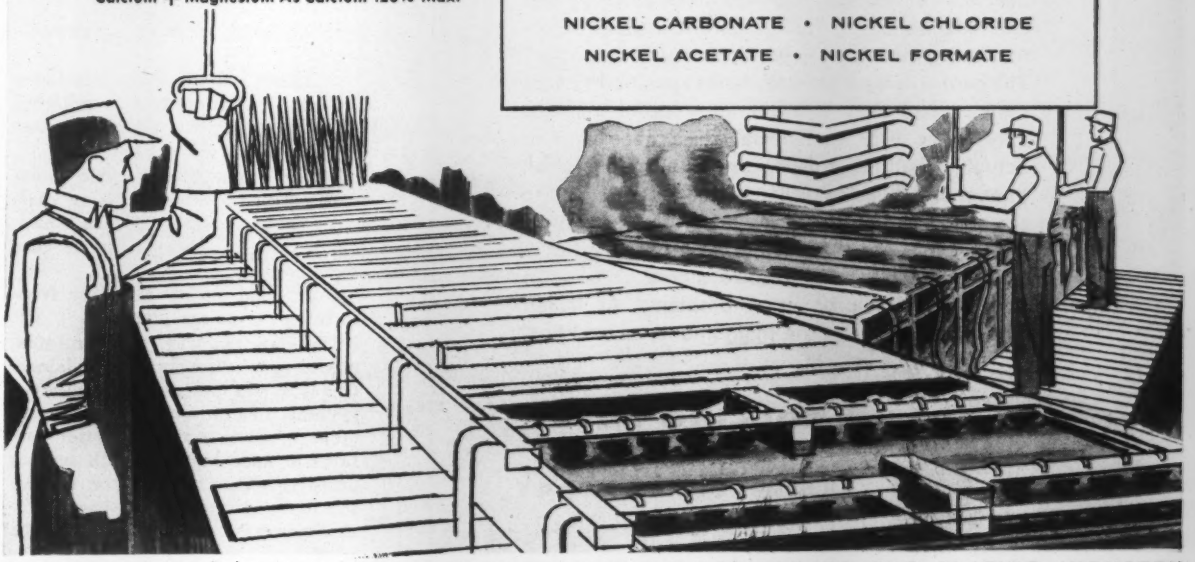

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related effects in spacecraft materials.

Problem is radiation heating

Dr. Francis J. Clauss, of Lockheed's Missile and Space Div. and technical chairman, explained that the problem is one of radiation heating, rather than aerodynamic heating. Clauss, describing the nature of the problem, says an earth satellite orbiting outside the atmosphere is alternately subjected to the blazing sun's rays, and during the time it is in the earth's shadow, to the near absolute zero of the black void of outer space.

Despite these extremes of temperature, the satellite must maintain a temperature similar to that on earth—neither too hot nor too cold for equipment to operate or for passengers to survive.

Since space is essentially a vacuum, aerodynamic heating is absent and heat transfer to and from spacecraft is almost entirely by radiation. Analysis of the problem, as pointed out in papers by W. G. Camack and D. K. Edwards, of Lockheed's Missile and Space Div. and by T. O. Thostesen, A. R. Hibbs and E. P. Buwalda, of the Jet Propulsion Laboratory of California Institute of Technology, indicates that earth satellites and other space vehicles receive heat from the following sources:

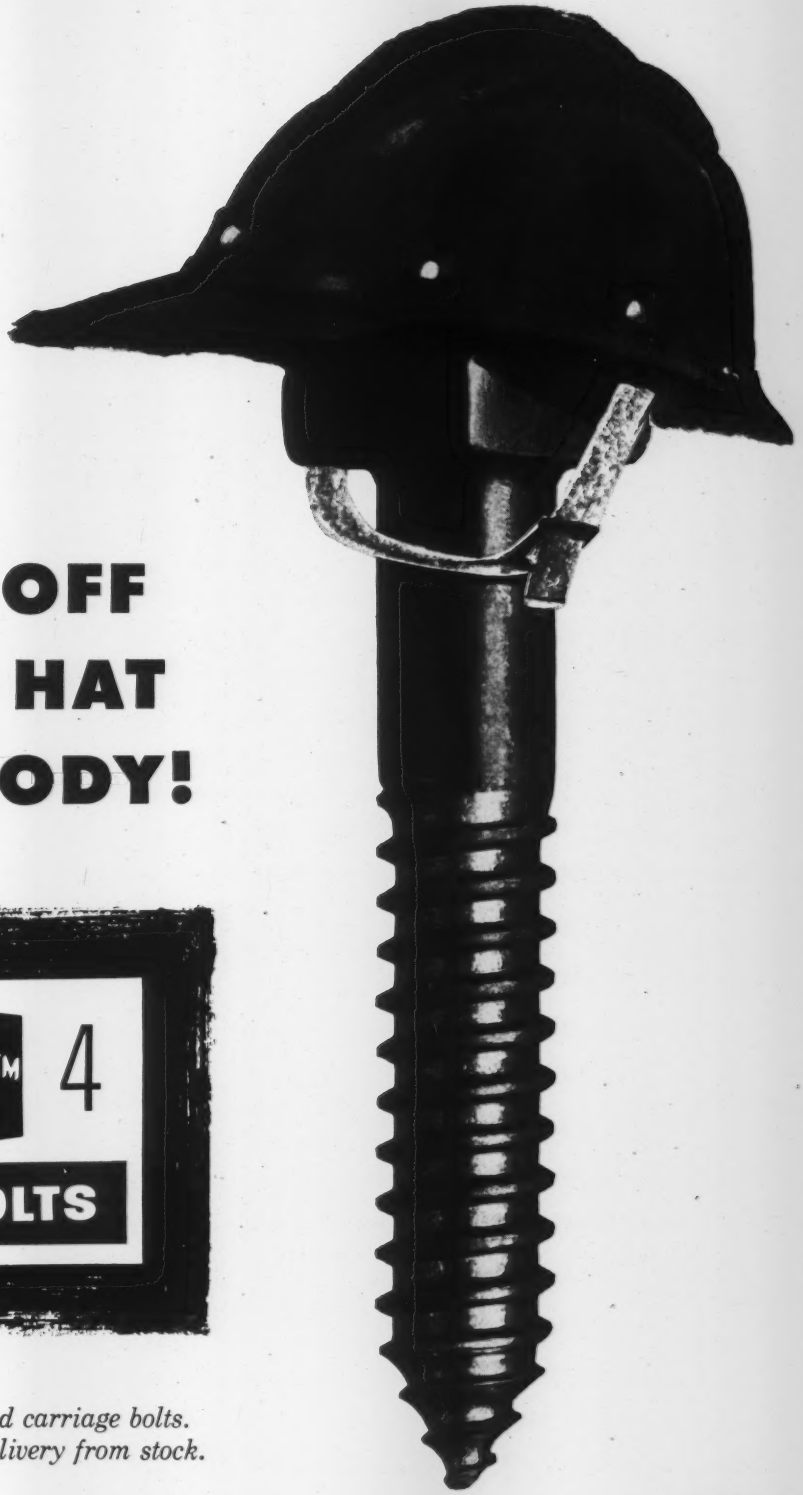
1. Insolation, or direct solar radiation.

2. Albedo radiation, which includes the solar radiation that is reflected or scattered by the earth's atmosphere back out into space.

3. Earth and atmospheric emission, which includes the solar radiation that is absorbed by the atmosphere or reaches earth and is then reradiated.

4. Internal heat released from batteries or power plants.

There are two ways to control temperature, the scientists explained. One is to add refrigeration and other systems. The other is a passive technique, i. e., to equip the outer surfaces of space vehicles with surface properties that are tailored for the job of receiving and emitting radiant energy in balanced amounts. The passive system provides a much more workable solution to the problem,



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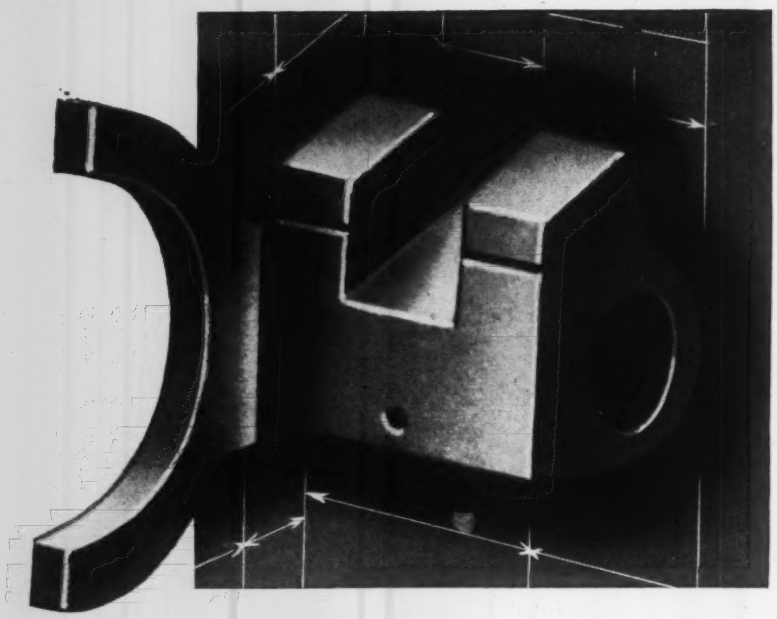

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since a huge weight penalty must be paid if an active system is used.

The principle of the passive system is similar to that involved in choosing summer clothing: dark clothing absorbs sunlight and makes the wearer warm, whereas light colored clothing reflects the sunlight and is cool. By using surface materials that have the proper values of absorptivity and reflectivity, the temperature of a body that is in radiation equilibrium with its surroundings can be controlled.

Need for precise laboratory measurements

W. Camack and D. K. Edwards of Lockheed pointed out the various factors that can cause improper temperature control in spacecraft materials resulting from an incorrect orbit or from improper surface properties.

These factors include: 1) lack of precision in laboratory measurements, 2) lack of control in manufacturing processes, and 3) lack of surface stability when material is exposed to space environments.

Passive temperature control systems in satellites

T. O. Thostesen of the Jet Propulsion Laboratory of California Institute of Technology spoke on the application of passive temperature control systems to the Explorer satellites and Juno II space probes.

Thostesen noted that results obtained from the flights of the Ex-

Small acetal plastics parts—The cam gear, coupling, pawl, bobbin jacket and locknut shown here are injection molded by Gries Reproducer Corp., 153 Beechwood Ave., New Rochelle, N. Y. from Du Pont's Delrin acetal resin (see M/DE, Jan '58, p 155). The small plastics parts (among the first produced from Delrin) weigh less than 1 gm each.

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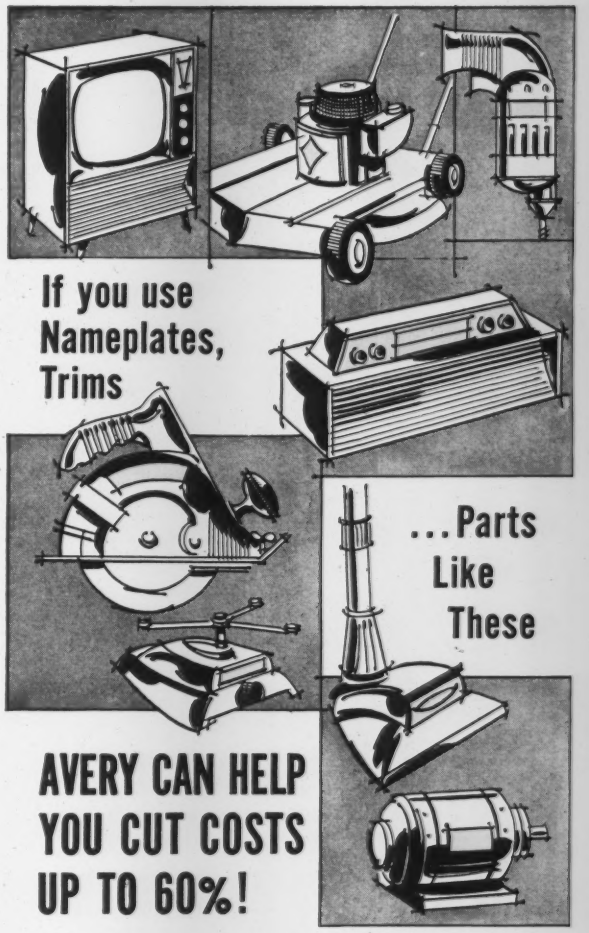

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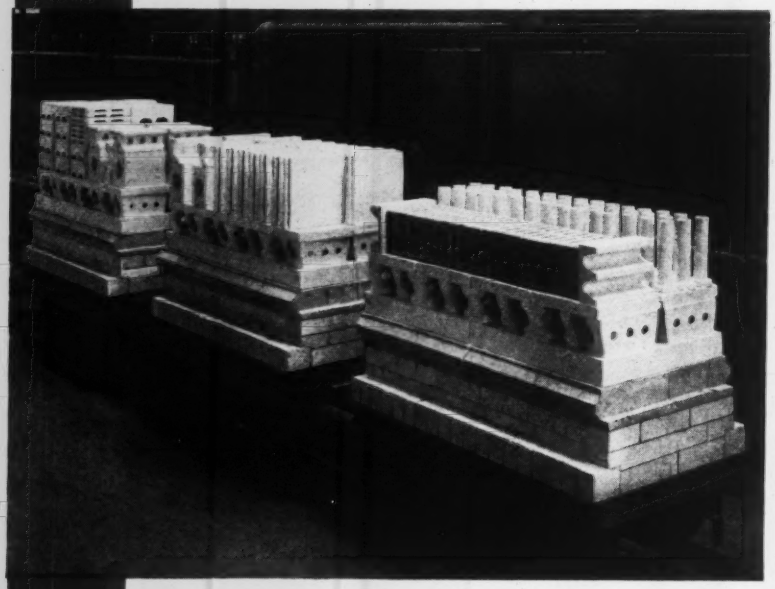

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plorer satellites and the Pioneer III and IV moon probes indicate that passive techniques for temperature control are possible, at least for trajectories that do not carry the body so far away from the earth's orbit that the solar constant is itself changed appreciably.

Ceramic coatings for passive temperature control

The general types of ceramic coatings, and their use for passive temperature control systems were discussed in a paper by J. C. Richmond of the National Bureau of Standards. Types of coatings discussed included 1) porcelain enamels, 2) high temperature ceramic coatings, 3) cement-type coatings, and 4) flame sprayed ceramic coatings. According to Richmond, ceramic coatings are more stable than organic coatings as far as the effects of ionizing radiation and vaporization in high vacua are concerned.

Effect of space environments on properties of materials

Papers presented during the second day of the symposium dealt with the effects of the environmental conditions of space on the surface and structural properties of materials. Among the conditions considered were: 1) greatly reduced atmospheric density, or high vacuum, 2) radiation, 3) micrometeorite bombardment, and 4) molecular and atomic sputtering.

At the extremely low pressures of outer space, materials evaporate or sublime at appreciable rates, and entire bodies can literally "disappear into thin air" with time. Long before this could happen, however, enough material can sublime from the surface layers to alter emittance and reflectance, thereby upsetting the delicate thermal balance. According to G. F. Matacek, Wright Air Development Center, silicone rubber was the only material that withstood exposure to temperatures above 500 F

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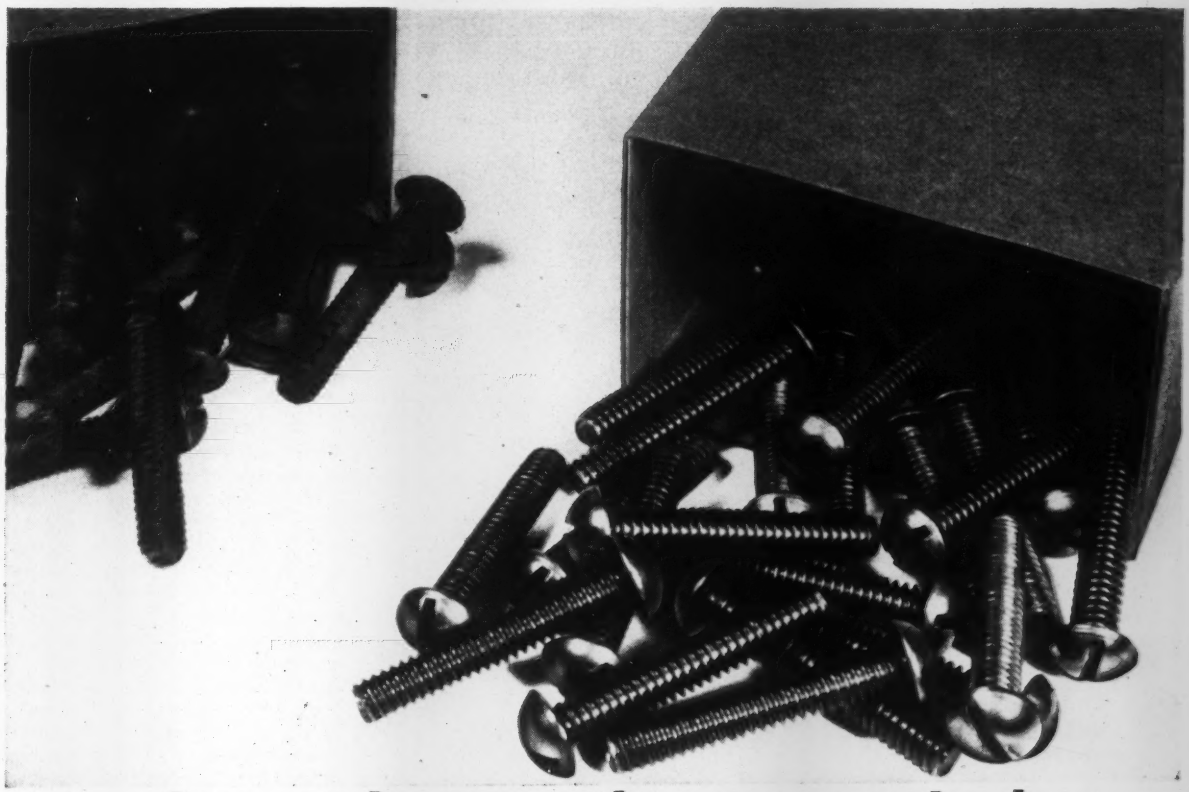

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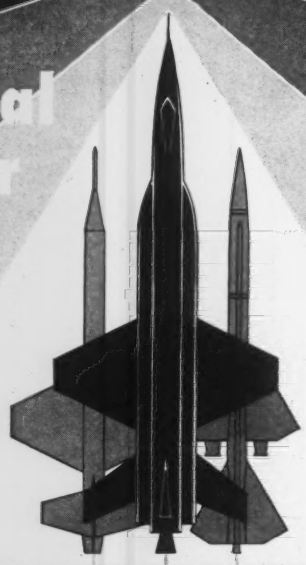

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Effect of atmosphere on properties of metals

Mechanical properties of metals are affected by the atmosphere in which they are measured. A metal can be either stronger or weaker when tested in a vacuum as compared to its strength in air.

M. R. Achter, U. S. Naval Research Laboratory, described studies on the creep rupture and fatigue behavior of alloys at high temperatures. He says that creep-rupture lives were longer in a vacuum than in air at higher stresses and lower temperatures, and shorter at lower stresses and higher temperatures. This is explained by two competing processes. One process (oxidation strengthening) is dominant at low creep rates, whereas the other process (reduction of strength by lowering surface energy) is dominant at high creep rates.

Lubricants in a high vacuum

Lubrication, another very difficult problem in high vacua, was discussed by Bruce Daniel of Midwest Research Institute. Liquid lubricants evaporate and graphite ceases to lubricate in a high vacuum, according to Daniel. However, two materials that are excellent lubricants in a high vacuum are the disulfides of molybdenum and tungsten.

Ultraviolet radiation in space

Ultraviolet radiation is much more intense in space than on earth because most of the short wavelength radiation is absorbed by the earth's atmosphere.

J. E. Cowling described research at the Naval Research Laboratory on the effects of ultraviolet radiation on film-forming organic polymers and resins that might be used as the matrix of spacecraft coatings.

Polyvinyl chloride lost 80% of its original weight after 50-hr exposure to ultraviolet light from a mercury vapor lamp under normal atmospheric conditions. Urea formalde-

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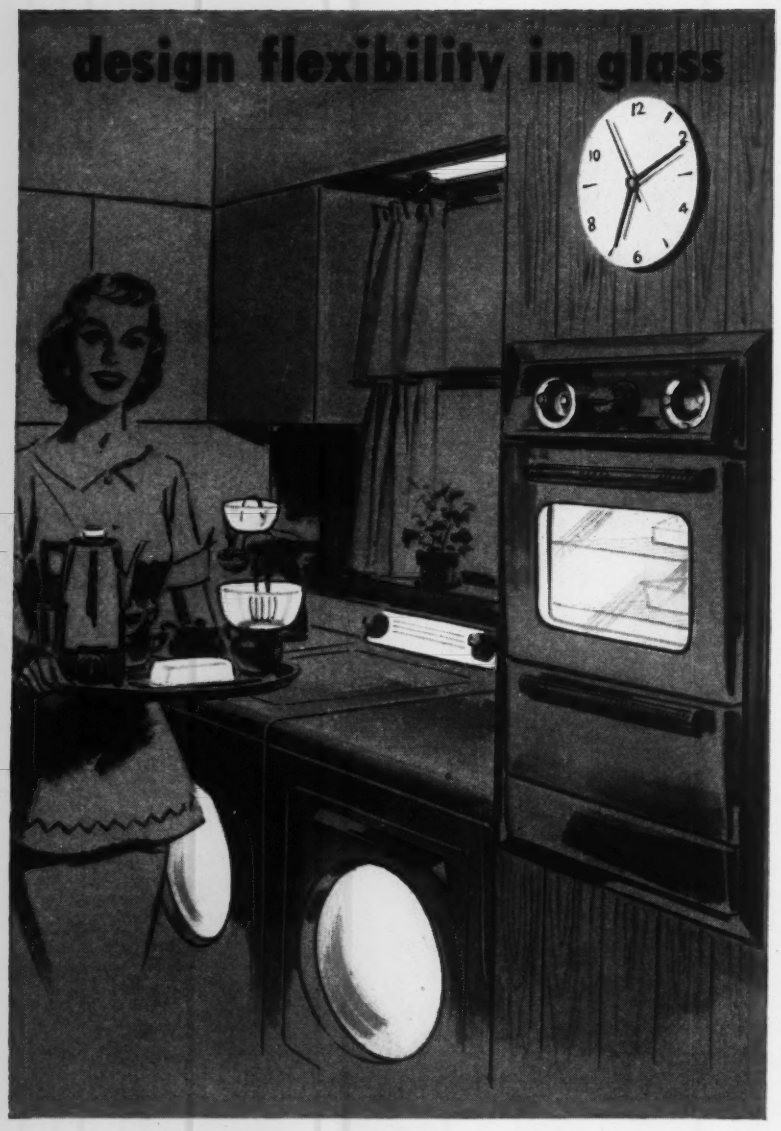

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hyde and melamine formaldehyde were the most stable polymer films studied, with losses of about 5% in weight after 50-hr exposure.

Polymer degradation was considerably less in a vacuum than in air, and the high rates of degradation usually associated with ultraviolet radiation were shown to depend on the presence of oxygen.

Micrometeorite bombardment

The last two papers of the symposium dealt with the bombardment of space vehicles by small, solid particles such as micrometeorites (also called interplanetary dust), atoms and molecules. The problem associated with small particles is their scouring or sandblasting action on temperature control surfaces, rather than puncture of the skin, such as might be caused by larger particles.

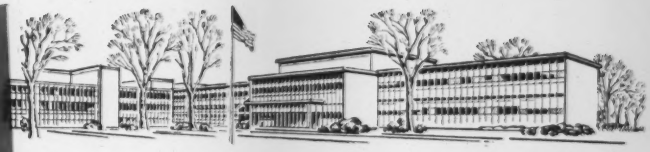
The distribution of interplanetary dust and its erosion effects were discussed by D. B. Beard of the University of California. According to Beard's calculations, the number of small particles (with diameters less than 10 μ) that can be expected to strike a space vehicle is about 30 to 300 impacts per year per sq cm of surface. Beard believes that micrometeorites will not cause significant erosion to surface oxide coatings such as alumina. He believes that other causes of erosion, such as solar corpuscular radiation and possible atmospheric oxygen, would be of greater consequence.

Atomic and molecular sputtering

Atomic and molecular sputtering was discussed by R. P. Stein of Lockheed. Sputtering refers to the erosion of a metal by impact of a high velocity atom or molecule, in which the eroded material leaves the surface in the form of single atoms. As in the case of micrometeorite erosion, it is not certain just how serious a problem sputtering is, and several different theories of sputtering have been proposed. According to Stein,

WATCH FOR 'SELECTOR'—The third edition of M/DE's *Materials Selector*—revised, expanded and updated—will be published later this month. The special issue is included in the M/DE subscription.

HAYNES ALLOYS



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Design engineers, metallurgists, and physicists may see in these new metals and alloys opportunities for a breakthrough in applications where limited properties of other metals have presented obstacles. Our research scientists, engineers, and technicians will gladly help you discover whether they can help improve your products.

HAYNES Tantalum

Close to 100% pure, chemically. It is produced by the consumable-electrode process. Practically inert to a wide variety of corrosive media, with these added advantages: *Wide* sheets with improved welding characteristics, making it easier to use in chemical and pharmaceutical equipment where corrosion and product contamination must be minimum. Pictured is tantalum reactor liner being welded inside tank of inert gas.

LARGEST Tantalum Lined Reactor

An outstanding example of what can be accomplished with the greater sheet width and improved welding characteristics of HAYNES Tantalum is shown above. The vessel—the largest tantalum-lined reactor ever constructed—is a 30-gallon unit designed to operate at 630 deg. F. and 500 psi. Every part that will be exposed to corrosives, including the agitator, is made, or sheathed with, HAYNES Tantalum. For full details on this new material, write for descriptive booklet.

HAYNES ALLOYS

HAYNES STELLITE COMPANY

Division of Union Carbide Corporation

Kokomo, Indiana

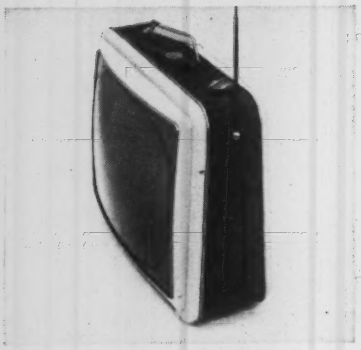
UNION CARBIDE

Address inquiries to Haynes Stellite Company, 420 Lexington Ave., New York 17, N. Y.

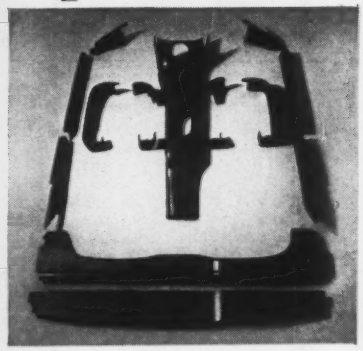
"Haynes," "Haynes Stellite," and "Union Carbide" are registered trade-marks of Union Carbide Corporation

For more information, turn to Reader Service card, circle No. 522

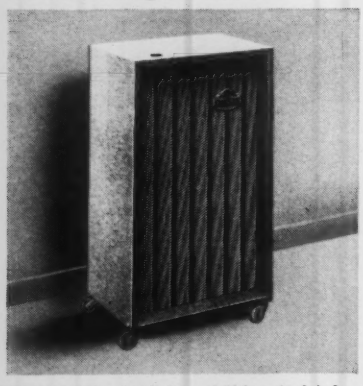
New Vinyl-Metal Laminate steps up styling and sales for 4 famous products



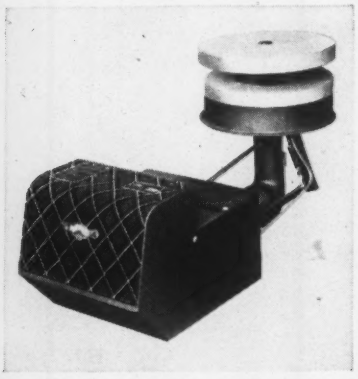
PHILCO rigidly tested many casing materials for its handsome new portable Seventeener TV. Only Colovin laminate could provide the twin advantages of realistic cost plus the luggage smartness of authentic alligator finish.



THUNDERBIRD interior presents an uninterrupted flow of leather-grained Colovin vinyl which matches exactly both upholstery and painted surfaces. Laminated parts are machined on standard equipment.



EBCO Oasis dehumidifier is high-styled with tweed-finish Colovin vinyl bonded to 22 gauge steel. Case is pierced, notched, drawn, formed and folded on same equipment used for metal alone. Cost of finishing is eliminated.



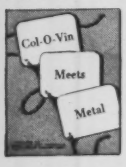
ROBERTS-GORDON dramatically "trademarks" its conversion burner with a custom reproduction of the actual Gordon plaid in Colovin vinyl laminate. The vinyl "costs but pennies more than previous painted components."

Send for "Colovin Meets Metal"

Contains laminate samples, multi-color printing, embossed effects, textures, test specifications, industrial applications, and a list of laminators to whom we supply Colovin vinyl sheeting. Send for it.

COLOVIN®

first and finest in vinyl laminates



COLUMBUS COATED FABRICS CORP., Dept. MD-1059, Columbus 16, Ohio

Please send me your brochure, "Colovin Meets Metal."

Name_____

Company_____

Address_____

City_____ Zone___ State_____

For more information, turn to Reader Service card, circle No. 454

two important items are missing in our knowledge of sputtering:

1. The effectiveness of atmospheric atoms and molecules in removing surface atoms (or the ratio of sputtered atoms to incident particles).
2. The threshold energy of structural materials (or the minimum energy needed by incident particles to cause sputtering).

Wool Felt Insulations Faced with Foil, Film

A line of wool felt insulations with a variety of surface facings has been introduced by Baldwin-Ehret-Hill, Inc., 500 Breunig Ave., Trenton 2, N. J. The felts are said to be lightweight, resilient, incombustible, noncorrosive and moisture resistant. They are easy to cut and fit with a knife or saw.

Facings include reinforced aluminum foil laminated with flameproofed kraft paper, aluminum-pigmented vinyl film and embossed aluminum foil.

The felts are expected to find use in such high temperature applications as ovens, dryers, stoves and ducts. Low temperature applications might be freezers, cold storage facilities, locker plants and air conditioning systems.

The felts, made from spun mineral fibers with a phenolic resin binder, are said to insulate at temperatures from below zero to 450 F. If mechanically supported and enclosed, the

***Insulating a storage tank** with a mineral wool felt faced with black kraft vapor barrier paper.*

For more information, turn to Reader Service card, circle No. 419

DO YOU HAVE AN IDEA...

THAT SOME FUNCTIONAL METAL PART COULD BE MADE BETTER OR CHEAPER BY ALUMINUM EXTRUDING?

Bring your idea to specialists in adapting aluminum extrusions to new functional parts applications. G. E. I.'s engineers are ready to consult with you, without obligation, on one part or a million.

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Consult your classified phone book under Aluminum Products

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SAVE *with--*
RELY *on--*
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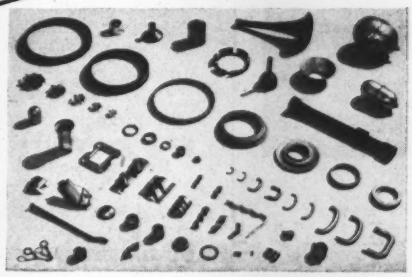
SPECIAL FORMED *and* DEEP DRAWN *Intricate, Light & Medium*



Parts shown range from ½" to 8" in size.

METAL STAMPINGS

Exacting tolerances, strength and surface finishes of parts made of copper, brass, aluminum, Monel, stainless, high carbon and alloy steels.
Operating 50 pieces of production equipment to blank, pierce, form, draw, swedge, coin, drill, tap, heat treat, anneal, silver braze, test and assemble. Complete tool room facilities for producing all dies. Modern inspection equipment assures quality control.
Accurate quotations furnished with breakdown as to tool cost and piece price. Our engineering staff is available for consultation, without cost or obligation to you.

Write for free brochure—

The Reichert FLOAT & MANUFACTURING CO.
2271 Smead Avenue • Toledo 6, Ohio
ESTABLISHED 1924

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SLASH ASSEMBLY COSTS!

...When You Use The
Fasson Self-Adhesive Method!

Nameplates, trims, emblems, service diagrams, etc., made of Fasson self-adhesive materials do a remarkable job simplifying assembly . . . cutting costs wherever used!

Drills, special tools and fasteners of all kinds are eliminated. To apply, simply remove the backing paper and press in place. That's all.

Result: assembly lines move much faster . . . and costs of labor, tools and materials go way down!

Check the Fasson self-adhesive method today. You'll discover many new ways to cut your costs . . . many new ways to add new glamour and beauty to your products!

Write today for samples and descriptive brochure to Dept. T-10.

fasson | Fasson Products

A Division of Avery Adhesive Products, Inc.
ELmwood 2-4444 • 250 Chester Street • Painesville, Ohio

For more information, turn to Reader Service card, circle No. 433

PROTECTING THE PROTECTOR!
the unprecedented launching complex for the TITAN intercontinental ballistic missile is fully protected, above ground and underground, with
Zincilate
Artist's conception of Titan Launching Complex; Courtesy American Machine & Foundry Company.

Surfaces of structural steel and aluminum on the Air Force's Titan Missile Launcher System are protected against corrosion with Zincilate. Zincilate is supplied to American Machine & Foundry Company, associate contractor under the Ballistic Missiles Division of the USAF.

Zincilate, as modern as the missile equipment it protects, provides true galvanic protection to iron, steel and aluminum. Easily applied, before, during or after fabrication, without requiring special equipment or even mixing. Now in its 13th consecutive year of sea coast exposure tests, Zincilate has yet to show any signs of rust. Write for complete information; samples available.

PROTECTION that SELLS your PRODUCTS
INDUSTRIAL METAL PROTECTIVES
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For more information, turn to Reader Service card, circle No. 521

felts can be used satisfactorily at temperatures up to 600 F. They are supplied in densities ranging from 3 to 8 lb per cu ft.

Polyethylene Resins Are Dust Resistant

Injection molded housewares and other products made of new polyethylene compounds are said to be relatively free of dust. Reason: the compounds do not retain dust-attracting static electricity after molding.

The compounds are reported to be the first such polyethylenes available with "anti-dust" properties. Dust resistant polystyrene resins were introduced late last year (see M/DE, Dec '58, p 148).

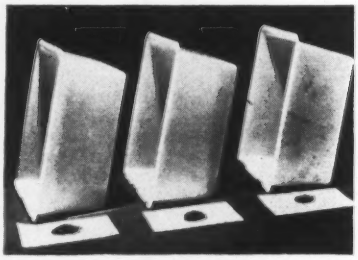
Two compounds developed

The dust resistant polyethylene compounds were developed by Union Carbide Plastics Co., Div. of Union Carbide Corp., 420 Lexington Ave., New York 17. Two compounds are available:

DPD-7366 is a dust resistant grade of a new polyethylene copolymer discussed in the July '59 issue of this magazine (p 137). The material, believed to be an acrylate copolymer, is said to have outstanding low temperature toughness, improved rigidity and good flex life.

DNDA-0401 is a high flow, general purpose housewares material with less rigidity than DPD-7366.

Both compounds are said to have



Two polyethylene containers *made of new "anti-dust" compounds repel dust, whereas the third container, made of a conventional resin, attracts dust. Each container was rubbed with a cloth and placed before a pile of cigarette ash. The picture was taken 1 min later.*

The X-ray fluorescence analyzer, one of the many modern instruments in the chemical laboratory, helps Jessop make certain you get the specified per cent of each alloy in your specialty steel.

"How X-rays help Jessop give you exactly what you want in alloy steels . . ."

—C. M. Carlisle, Director of Analytical Chemistry

"What's happening here? As the stylus in the X-ray fluorescence analyzer draws red lines on the graph, the Jessop chemist determines the exact per cent of each alloy in a sample of specialty steel.

"Based on this analysis, the melter may ask for the addition of, say, molybdenum to the molten steel now in electric arc furnace No. 3.

"How's it done? Bombarded by X-rays, the alloys in the sample of steel are radiating secondary rays. Converted into electrical energy, the rays are causing the stylus to move and draw red lines on the graph . . . indicating the types and per cent of alloys in the steel sample."

In the Jessop chemical laboratory, the X-ray fluorescence analyzer and many other modern instruments help us make certain you get the exact chemical composition specified in your order. This chemical laboratory is one more reason for your confidence in ordering specialty steels from Jessop. *Specify Jessop . . . and then relax!*

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Stainless, alloy, tool, cast-to-shape, and forging steels, precision ground flat stock, and other specialty steels

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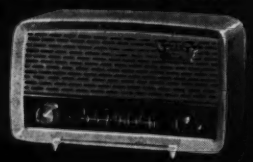
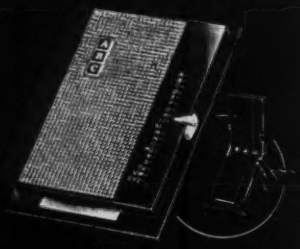
OUTSHINE



YOUR

COMPETITION



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Dress up your products inexpensively with fabulous metalized Mirro-Brite Mylar. Choose from gleaming gold, chrome or copper, in plain or beautifully embossed patterns that can be die-cut to any shape and applied in seconds because of its pressure sensitive adhesive backing! Available in continuous rolls or cut-to-size sheets. Our Technical Staff is available without obligation to analyze your specific needs. Inquire NOW!

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*Mylar — Dupont Polyester Film

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Manufacturers of Mirro-Brite "Mylar," Acetate, Polystyrene and Butyrate

For more information, circle No. 401

What's new IN MATERIALS

PROPERTIES OF POLYETHYLENE COMPOUNDS

Type	DPD-7366	ONDA-0701
PHYSICAL PROPERTIES		
Density, gm/cu cm	0.935	0.925
Melt Index, gm/10 min.	8	25
MECHANICAL PROPERTIES		
Tensile Strength, psi.	1,600	1,400
Elongation, %	210	134
Yield Strength, psi	1,500	1,300
Secant Modulus, psi	40,000	29,000

all the other desirable properties of high quality polyethylene compounds. They are recommended for such housewares as tumblers and refuse cans.

ASME Code Covers Ti Pressure Vessels

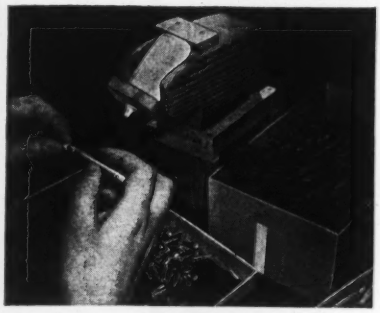
An ASME Code (Case No. 1258) has been issued covering the use of titanium in unfired pressure vessels. The Code specifies that the base material be unalloyed titanium conforming in chemical composition and mechanical properties to ASTM specifications for Grades 1, 2 and 3 of B265-58T (see Table 1).

Issuance of the Code should reduce time-consuming and costly investigations hitherto called for when titanium assemblies were required. The Code should also enable state

TABLE 1—TITANIUM SPECIFICATIONS (ASTM B265-58T)

Ti Grade →	1	2	3
COMPOSITION (%)			
Nitrogen, max.	0.05	0.05	0.07
Carbon, max.	0.10	0.10	0.10
Iron, max.	0.20	0.20	0.30
Hydrogen, max.	0.015	0.015	0.015
Oxygen, max.	0.25	0.25	0.35
Titanium	Bal	Bal	Bal
MECHANICAL PROPERTIES			
Ten Str (annealed; min), psi	40,000	50,000	60,000
Elong (in 2 in.; min), %	22	20	18
Yld Str (0.2% offset; ann.), psi			
Min.	30,000	40,000	50,000
Max.	55,000	65,000	75,000

No. 6 of a series



Eastman 910 Adhesive solves another production bottleneck

The Waterman-Bic Pen Corp., of Seymour, Conn., manufacturer of fine writing instruments, introduced recently the Jewel-Point, a high ink capacity, synthetic sapphire ball-point pen.

In designing the pen, Waterman-Bic investigated adhesives as a faster, more economical way of joining the metal nose cone to the plastic barrel.

After extensive testing, their engineers found quick-setting high-strength Eastman 910 Adhesive to be the answer, eliminating more costly threading.

In production, a drop of adhesive is placed on the end of the plastic barrel. The barrel is inserted into the brass nose cone. A quick twist to spread the adhesive...*and the bond is formed.*

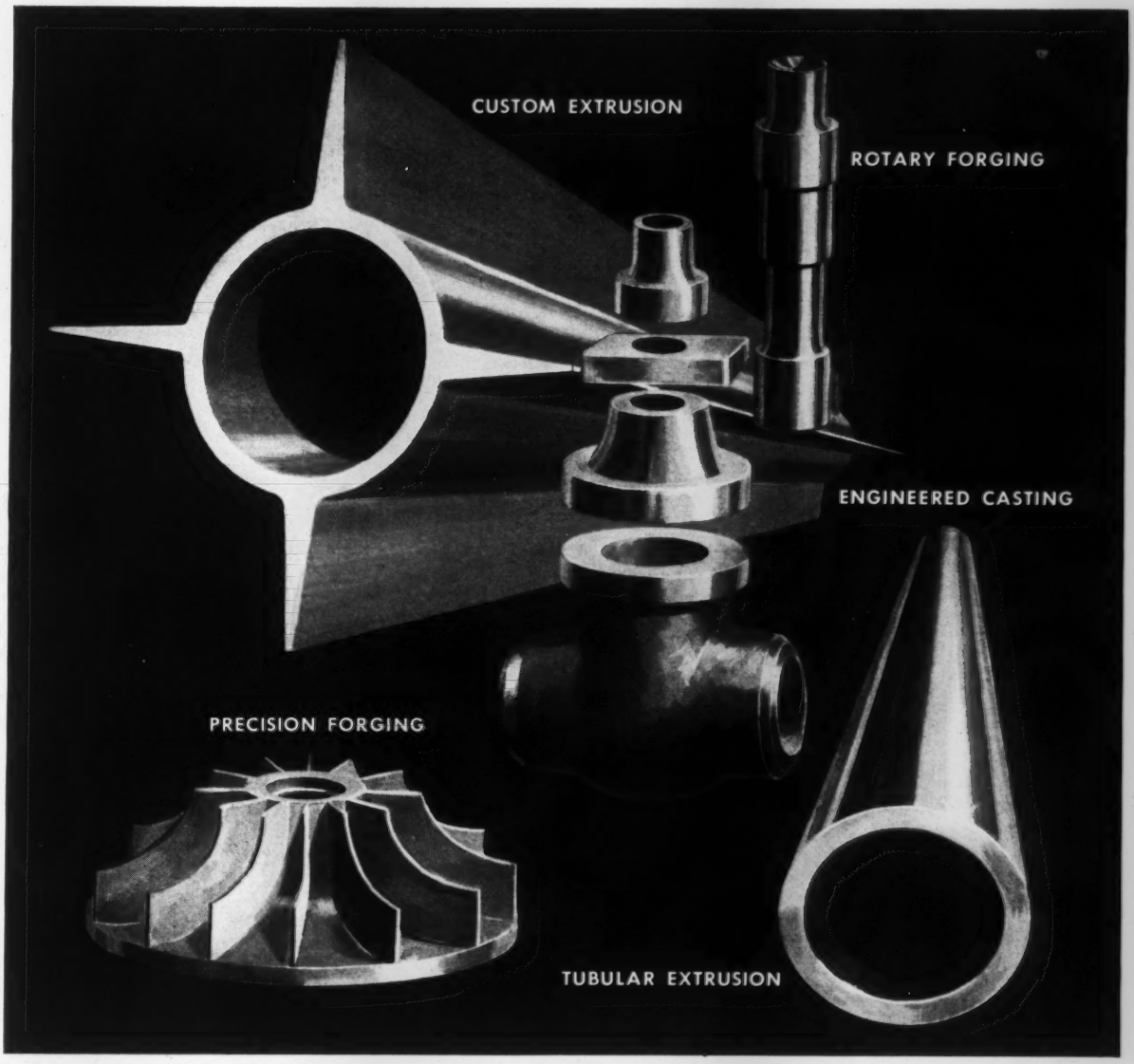
Eastman 910 Adhesive is making possible faster, more economical assembly-line operations and new design approaches for many products. It is ideal where extreme speed of setting is important, or where design requirements involve joining small surfaces, complex mechanical fasteners or heat-sensitive elements.

Eastman 910 Adhesive is simple to use. No mixing, heat or pressure is required. Upon spreading into a thin film between two surfaces, setting begins immediately. With most materials, strong bonds are made in minutes.

What production or design problem can this unique adhesive solve for you?

For a trial quantity (⅓-oz.) send five dollars to Armstrong Cork Co., Industrial Adhesives Div., 9110 Dunbar Street, Lancaster, Pa., or to Eastman Chemical Products, Inc., Chemicals Div., Dept. E-10, Kingsport, Tenn. (Not for drug use)

For more information, circle No. 445



CURMET premium quality works for you in products like these

Curtiss-Wright Metals Processing brings out the best that an alloy can offer—steps up the performance of forgings, castings and extrusions—helps underwrite the performance of your product in use.

For example, exclusive CURMET rotary forging places the metal where it is designed to be on a stepped shaft, reducing chip production cost up to 50%. CURMET ceramic mold casting reproduces so closely to blueprint that non-machinable alloys can be cast, giving your product far greater wear resistance.

This is true with each of the CURMET precision methods for shaping hard-to-work metals. Further, production facilities are integrated . . . the large 40-foot stainless steel extrusions you require can be delivered heat treated to optimum strength level, the close-tolerance forgings you need can be finish machined and assembled . . . all within the CURMET one-source service.

To strengthen your product or process by putting premium quality to work for you, call the nearest CURMET representative or write for full information.

Visit us at booth 1730, National Metals Exposition, Chicago, Nov. 2-6

CURTISS-WRIGHT CORPORATION **METALS PROCESSING DIVISION**

76 GRIDER STREET BUFFALO 15, NEW YORK

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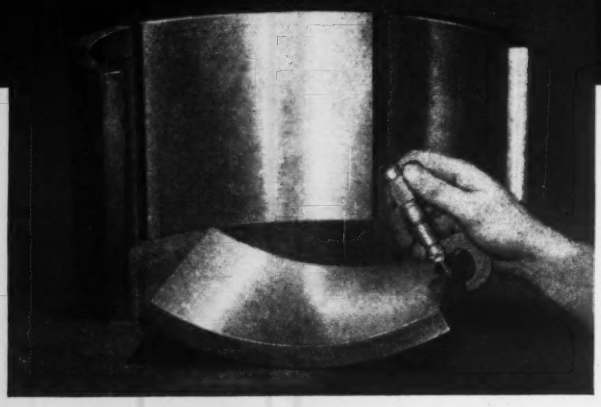
How Fansteel 77 Metal PLUS Fansteel Engineering



added up to a $10,000 Saving!

Fansteel does more than just talk "customer savings." Take the case of these Fansteel 77 Metal contour parts, ¾" thick x 9½" high x 15" developed length with a radius of 9".

Fansteel engineers developed new fabrication techniques which cut the cost 30% over former methods of producing the part. To the customer this added up to a $10,000 saving on this one order alone.

It's just one more example of how the constant search by Fansteel engineers for cost-cutting ways of fabricating Fansteel metals, pays off in big savings for the customer.

Investigate the possibilities of similar savings on your parts... whether it's made from 77 metal, tantalum, molybdenum, columbium or tungsten. Call in the Fansteel man.

NEED A METAL 50% HEAVIER THAN LEAD?

Fansteel 77 is a metal produced especially for applications requiring maximum density in limited space. It is twice as heavy as steel, 50% heavier than lead, yet—much stronger than cast iron. Non-magnetic 77 Metal is easily machined and easily joined to other metals. Furthermore, it is **non-toxic** and **non-radioactive** requiring no special precautions in handling. Available in finished or semi-finished parts to your specifications or in bars, rods, rings, disks, special shapes.

K598A

FANSTEEL

Fansteel Metallurgical Corporation
North Chicago, Illinois
U.S.A.

For more information, turn to Reader Service card, circle No. 499

TABLE 2—MAXIMUM ALLOWABLE STRESSES FOR TITANIUM METAL (ASME Code, Psi)

Grade →	1	2	3
70 F	10,000	12,500	15,000
100 F	9,600	12,000	14,000
200 F	7,950	10,400	11,400
300 F	6,500	8,900	9,600
400 F	5,500	7,900	8,250
500 F	4,700	7,000	7,150
600 F	4,000	6,250	6,400
650 F	3,750	5,950	6,100

building inspectors to approve construction of such equipment as titanium heat exchangers, heating coils, tanks and similar assemblies.

Also included in the Code are welding requirements, inspection and stress relief procedures, and allowable stress values of titanium metal at temperatures from 70 to 650 F (see Table 2).

Copies of the Code covering titanium are available from Titanium Metals Corp. of America, 233 Broadway, New York 7.

Reinforced Ceramic Resists Gas Erosion

A special reinforced ceramic has made possible a re-entry nose cone that resists gas erosion at extreme temperatures and eliminates structural failure due to heat shock.

The ceramic, called Avcoite, was developed by Avco Research & Advanced Development Div., 201 Lowell St., Wilmington, Mass. The material is said to be "quasi" ductile. Excessive stresses cause it to deform rather than fracture.

The actual nature of the material and its method of manufacture cannot be disclosed for security reasons, according to Avco.

Ablative-type ceramic

The long, slender, advanced design of the ceramic nose cone uses the ablating principle in which very high heat resistant materials are "cooked away" to carry off excessive heat generated during re-entry. This concept is said to permit much higher re-entry speeds than were possible with the earlier blunt-nosed shapes using the "heat sink" principle in which re-entry heat was ab-

Insulate to 2000° F. with REFRASIL

This may be the SPECIAL INSULATION you're looking for!

REFRASIL PHYSICAL PROPERTIES:

- Chemical resistance of pure silica
- Resists temperatures up to 3000° F. under certain conditions
- Low Thermal conductivity
- Fiber diameter .00020-.00040 in.
- Specific heat .19 (Batt)
- Thickness .14-.15 in. (Batt)
- Surface density .05 lb./sq. ft. (Batt)

REFRASIL USES:

- 2000° F. continuous high-temp. insulation
- Filtration of corrosive materials
- Removable, insulating blankets
- REFRASIL Reinforced Plastics (ASTROLITE for up to 15,000° for short duration)
- Thermocouple wire insulation
- Electric muffle furnaces
- Laboratory heating mantles

If you're looking for an efficient, lightweight 2000°-3000°F. insulating material in any of the physical forms shown above, REFRASIL may be your best answer.

Long proven for jet aircraft and missile use, REFRASIL is fast becoming an important industrial insulation for −300°F. cold to +3000°F. heat.

When other insulation materials fail in critical high temperature use, write or call for test samples of REFRASIL. It may be the *special* insulation you're looking for!

• *Write for REFRASIL Product Bulletin and Price List.*

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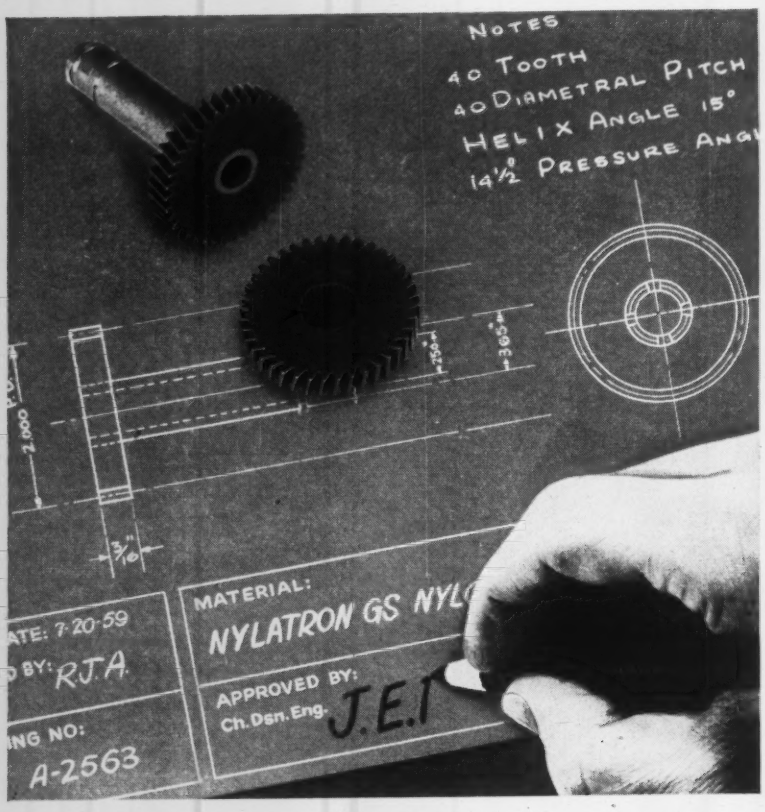
WRITE OR CALL YOUR NEAREST HITCO REPRESENTATIVE: EASTERN: Tom Kimberly, 38 Crescent Circle, Cheshire, Conn., BR. 2-6544; Fred W. Muhlenfeld, 6659 Loch Hill Rd., Baltimore 12, Md., VA. 5-3135 • **MIDWEST:** Burnie Weddle, 3219 W. 29th St., Indianapolis 22, Ind., WA. 5-8685 • **SOUTHWEST:** Marshall Morris, 2850A W. Berry, Rm. 7, Fort Worth, Tex., WA. 4-8679 **NORTHWEST:** J. L. Larsen, 5757 Oaklawn Pl., Seattle, Wash., PA. 5-9311 • **CANADIAN PLANT:** THE H. I. THOMPSON CO. OF CANADA LTD., 60 Johnston St., Guelph, Ont., TA. 2-6630

For more information, turn to Reader Service card, circle No. 526

where performance counts...



Nylatron® GS nylon

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—specified for outstanding properties—

Compared to conventional nylon,
NYLATRON GS molded parts display:

- Superior wear resistance
- Lower moisture absorption
- Exceptional dimensional stability
- Less deformation under load
- Higher heat distortion temperature
- Decreased stress—less warpage
- More rigid thin sections
- Increased tensile and flexural strength
- Properties similar to machined prototypes

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*Composition and use covered by United States Patent No. 2,855,377.

POLYPENCO*

For more information, turn to Reader Service card, circle No. 417

sorbed by a heavy metal cap.

As reported in the May '59 issue of this magazine, Avco's nose cone has successfully re-entered the earth's atmosphere after a flight at ICBM range and velocity.

Zinc Coating Protects Steel in Salt Water

An inorganic zinc coating, called Carbo Zinc No. 11, is said to provide a high degree of galvanic protection to steel in salt and fresh water, and solvent laden atmospheres. The electrical potential between steel and the coating is 0.55 to 0.60 v when immersed in brine or sea water, and 0.50 v when immersed in fresh water.

The coating, which is applied by brush, spray or roller, is said to be very similar to a hot dip galvanized coating. It was developed by Carboline Co., 32 Hanley Industrial Ct., St. Louis 17, Mo. The producer says the coating should be ideal for boats, pipes, storage tanks, fences, docks and smokestacks.

An outstanding feature of the coating is its rapid drying time. It dries and becomes water insoluble in 20 min. According to the developer the coating can be applied in moisture-laden air (100% RH) and at temperatures from –20 to 750 F. The new zinc coating can be used as single-coat protection or as a prime coat for organic and inorganic topcoats.

Hydraulic Fluid Is Fire, Wear Resistant

A new water-in-oil emulsion-type hydraulic fluid is characterized by:

1. Good fire and wear resistance properties.
2. Very high viscosity index (130).
3. Good film strength at high temperatures.
4. Good thermal stability when subjected to an operating temperature of 150 F.

The fluid, called Sunsafe, was developed by Sun Oil Co., Industrial Products Dept., 1608 Walnut St., Philadelphia 3. It is supplied in two grades—one for use in industrial machinery, the other for use in

EPON® 828 . . . from TOP to BOTTOM,

the recognized performance standard for liquid epoxies

Ever since its introduction a decade ago, Shell Epon 828 has set the pace as a uniform thermosetting plastic with a remarkably wide range of applications . . . from high-flying missiles to underground glass fiber pipe and pipe coatings. No other resin polymer combines such outstanding uniformity with *so many* other desirable properties.

A pourable liquid at room temperature, Epon 828 is a 100 per cent reactive resin that gives unexcelled performance in wet lay-up laminating of glass fiber, in potting and encapsulating electronic components, in casting, and in surface coating. In adhesive formulations, Epon 828 makes extremely strong bonds with metal, wood, glass, and many plastics . . . stronger often than welds or rivets.

Epon 828 is used in the manufacture of many products, new and old, such as boats, tools and dies, aircraft, commercial adhesives, and vinyl stabilizers. It is a principal ingredient in surface coating formulations that give films of almost unparalleled resistance to abrasion, impact and the attack of solvents, alkalis, and acids. A new and fast-growing use is in industrial floor surfacing compounds.

* * *

The unequalled uniformity of Epon 828 assures formulators of this wide range of applications. Only Shell Chemical offers you a *complete* line of epoxies. Write to your nearest Shell Chemical district office.

Epon puts the power in plastics

SHELL CHEMICAL CORPORATION
PLASTICS AND RESINS DIVISION

Central District	East Central District	Eastern District	Western District
6054 West Touhy Avenue	1578 Union Commerce Bldg.	50 West 50th Street	10642 Downey Avenue
Chicago 48, Illinois	Cleveland 14, Ohio	New York 20, New York	Downey, California

IN CANADA: Chemical Division, Shell Oil Company of Canada, Limited, Toronto

SHELL

For more information, turn to Reader Service card, circle No. 440

ABRASION PROBLEMS?

To get down to hard facts—Coors Space Age Ceramics are among the hardest common materials known! They are harder than silicon carbide and are comparable to sapphire, having a hardness rating of 9 on Moh's Scale and a Knoop Hardness Factor of 1450 to 1750.

This means that if abrasion is likely to cut short the service life of the part you are designing, it will pay you to consider using Coors High Alumina Ceramic.

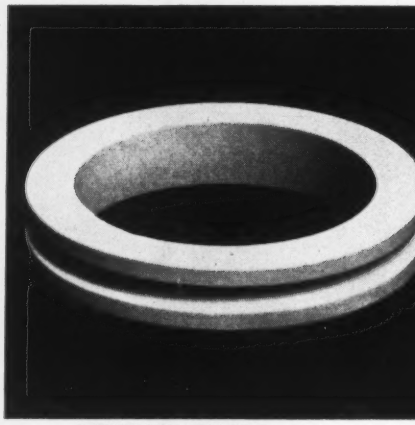
Of course, it is the extreme hardness and toughness of Coors Aluminas that provide superior resistance to wear and abrasion. But just as important in the design of a part are other properties. Coors Aluminas have outstanding mechanical strength—up to 34,000 psi tensile strength and over 300,000 psi compressive strength. They have permanent dimensional stability, superior impact resistance, are chemically inert and they can be fabricated to extremely close tolerances. Typical applications:

Seal Rings

Mechanical rotary seals are fast replacing the conventional stuffing box and packing gland in preventing leakage of liquids along the rotating shafts of pumps, agitators and similar equipment—abrasive applications as tough as they come.

Many thousands of these seal mechanisms are now being made with Coors High Alumina Ceramics as one of the two seal surfaces—the other surface being a graphite composition or a plastic such as nylon or teflon. Under special conditions, with pressures below 25 psi, an exceptionally good seal is obtained by running ceramic against ceramic—possibly because lapped surfaces can be made on the ceramic parts to 2 or 3 light bands of flatness. Most liquids act as a good lubricant because the ceramic is chemically inert.

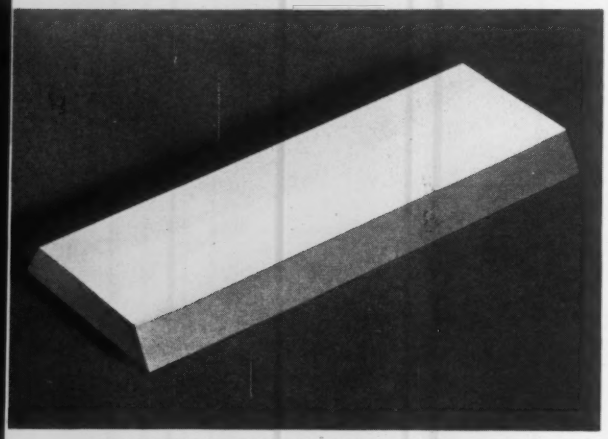
Dependability of Coors Aluminas in seal rings is demonstrated by the fact that they are widely used with radioactive or toxic material.



MECHANICAL SEAL RING

Standard Production Tolerances
Coors Ceramic Seal Rings

Flatness—Running Face ground and lapped to 3 light bands.
Parallelity of faces—within .002" T.I.R.
Concentricity—.005" T.I.R.
Outside Diameter—±.005"
Thickness—±.005"



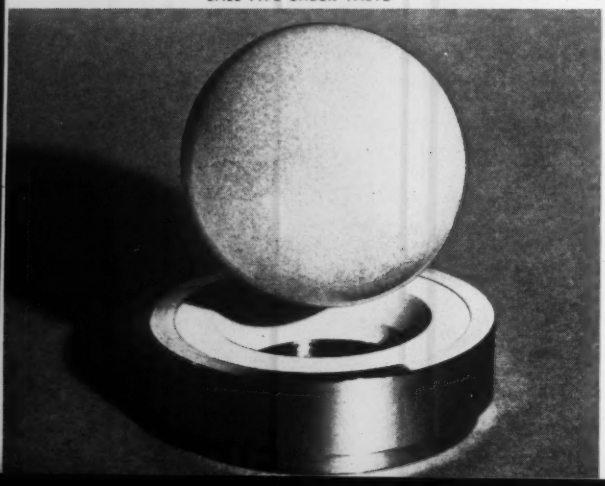
WEAR PLATE after 4½ months of service life, shows only slight wear. This Coors Ceramic plate replaced a plate of hardened tool steel which lasted only two days.

Wear Plates

Because of the extreme hardness of Coors High Alumina Ceramics, even swarf consisting of cutting oil, aluminum oxide cutting wheel grit and steel cuttings has little effect in cutting or abraiding parts made from the ceramic. This wear plate, for example, on a Production Centerless Belt Grinder was originally hardened tool steel. In grinding a .015" cut in steel tubing for precision hydraulic cylinders, grooves .05" deep were worn in the steel wear plate by the swarf in only two days, causing a loss of the required grinding tolerance. Now, made of Coors High Alumina Ceramic, wear in 4½ months has amounted to only .01"—the same wear put on the steel plate in a few hours!

Other applications range from oil field uses for metering chokes, mud gun nozzles and rock bit nozzles all the way to nose cones for missiles.

BALL TYPE CHECK VALVE



Ball Type Check Valves

Replacement of metal valve seats with Coors High Alumina Ceramic provides improved operation of filter press pumps. Metal seats previously used have lasted as little as three weeks in service. Valve seats made by Coors, inspected after months of service, show no sign of wear.

This is typical of applications where abrasive slurries are being controlled with ball type check valves using Coors Ceramic. For best results, both a Coors ceramic ball and seat are used. Coors Ceramic is chemically inert, so this type of valve is also useful for acid or some alkali applications. (Spherical ground balls of Coors AD-85 Ceramic are kept in stock. Special tolerances on balls extend up to ±0.000020".)

Coors offers a complete engineering service to assist you in utilizing these high strength ceramics to the best advantage. For complete properties and specifications, write for Bulletin 858.

Coors

COORS PORCELAIN COMPANY

600 Ninth Street, Golden, Colorado

What's new IN MATERIALS

Hot flame *does not ignite emulsion-type hydraulic fluid.*

hydraulically operated mining machinery. The fluid may be used with centrifugal, rotary and reciprocating hydraulic pumps incorporating plain or friction-type shaft bearings.

Stainless Steel Tubing Has High Strength

Small, cold drawn tubing made of PH 15-7 Mo stainless steel is now supplied by Superior Tube Co., 1548 Germantown Ave., Norristown, Pa. The stainless steel, announced in the fall of 1957 (see M/DE, Nov '57, p 174), can be heat treated to strengths as high as 260,000 psi. It is said to withstand temperatures to 1000 F.

The tubing is easily welded by procedures commonly employed in welding other stainless steels, and does not require preheating or post annealing. The tubing can withstand severe bending in the annealed condition.

The tubing seems suitable for structural parts, particularly those that are welded and which can be heat treated as a unit after assembly. Other potential uses include high strength studs and bushings for corrosive environments.

The stainless steel tubing is furnished in outside diameters from 0.012 to 1.125 in., and in wall thicknesses from 0.002 to 0.035 in.

Polyester Resin May Compete with Epoxies

A liquid polyester resin, with certain end-use characteristics approaching those of epoxies, has been developed by Atlas Powder Co.,

◀ For more information, circle No. 492

Air and Oil Channels Die Cast. No Costly Machining Necessary

LOW COST SOLUTION TO HIGH PRODUCTION COSTS

Die cast aluminum air drill handle manufactured by Production Die Casting for the Cleco Air Tools Division of the Reed Roller Bit Company.

Lawn edger blade guard

Drive belt gear

Sill cock

PRECISION DIE CASTING has helped manufacturers hold the price line in spite of steadily rising labor and commodity costs. This superior and economical method of fabricating component parts for trucks, automobiles, household appliances and many other products of wide application virtually eliminates the necessity for costly machining and finishing.

The most flexible shapes are cast accurately to close tolerances . . . ready for use. High tensile strength zinc and aluminum alloys mean **durability.** The die casting method means savings in time and money.

Call or write: Production Die Casting Company, the South's leading die caster.

Discover how die casting can help you cut costs.

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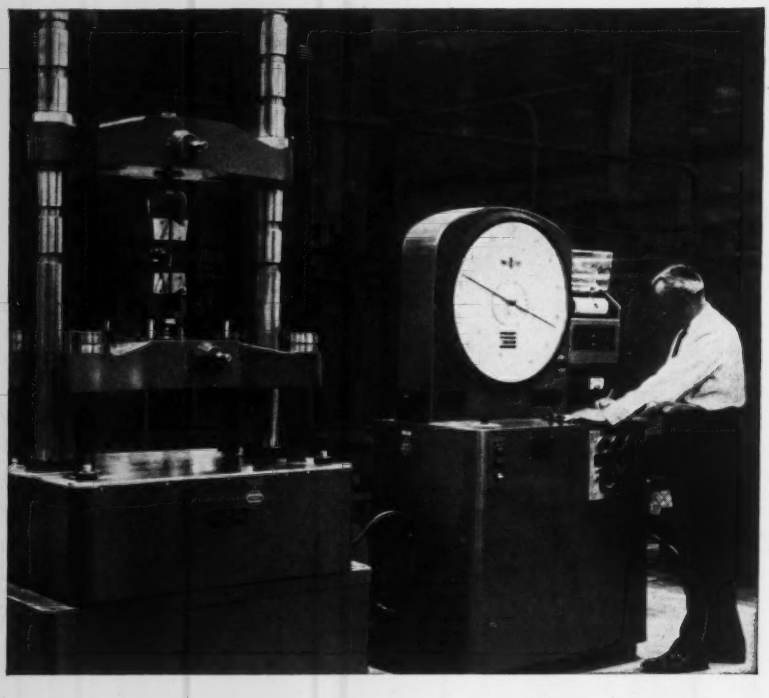


For Fast, Accurate Test Results
CONVAIR-ASTRONAUTICS DEPENDS on a TINIUS OLSEN ElecTmatic U.T.M.

Materials used in the Atlas intercontinental ballistic missile must meet exacting specifications to withstand the tremendous stresses and strains of outer space flight. Time is at a premium. Testing accuracy and reliability are assured by a Tinius Olsen ElecTmatic Universal Testing Machine used in the San Diego plant of Convair (Astronautics) Division of General Dynamics Corp.

Uniform testing speeds are maintained throughout the test by the variable speed motor drive. Any of four ranges, of as little as 1/100 capacity, can be selected during test. In addition, materials under test can be subjected to varying conditions of stress and strain with a built-in automatic cycling program controller.

Evaluate your testing program in terms of the unmatched flexibility and accuracy of a Tinius Olsen ElecTmatic—available in capacities from 500 to 1,000,000 lbs. Write for Bulletin 54 today.

TINIUS OLSEN
TESTING MACHINE COMPANY
2010 EASTON ROAD • WILLOW GROVE, PA.
Testing and Balancing Machines

Trademark
Reg. U.S. Pat. Off.

For more information, turn to Reader Service card, circle No. 422

Chemicals Div., Wilmington 99, Del. The resin, called Atlac L-382-13, is based on a bisphenol derivative reacted with fumaric or maleic anhydride. Advantages of the resin, as outlined by the company, are:

1. Good resistance to water, acids and alkalis at elevated temperatures.
2. Higher heat distortion temperature (285 F) than conventional polyesters.
3. Good electrical properties under humid conditions.
4. Lack of styrene "after-odor," making the material suitable for use with food.
5. A specific gravity 5 to 10% lower than that of conventional polyester resins, decreasing the cost of molded parts.

How Spring Materials Act in De-Ionized Water

by G. E. Galonian and H. L. Tymchyn*

The results of recent corrosion tests show that springs made of three different alloys—Haynes 25 (a cobalt-chromium-tungsten alloy), Inconel X (a nickel-chromium-iron alloy), and A-286 (an iron-nickel-chromium-molybdenum-titanium alloy)—have good resistance to high temperature, de-ionized water.

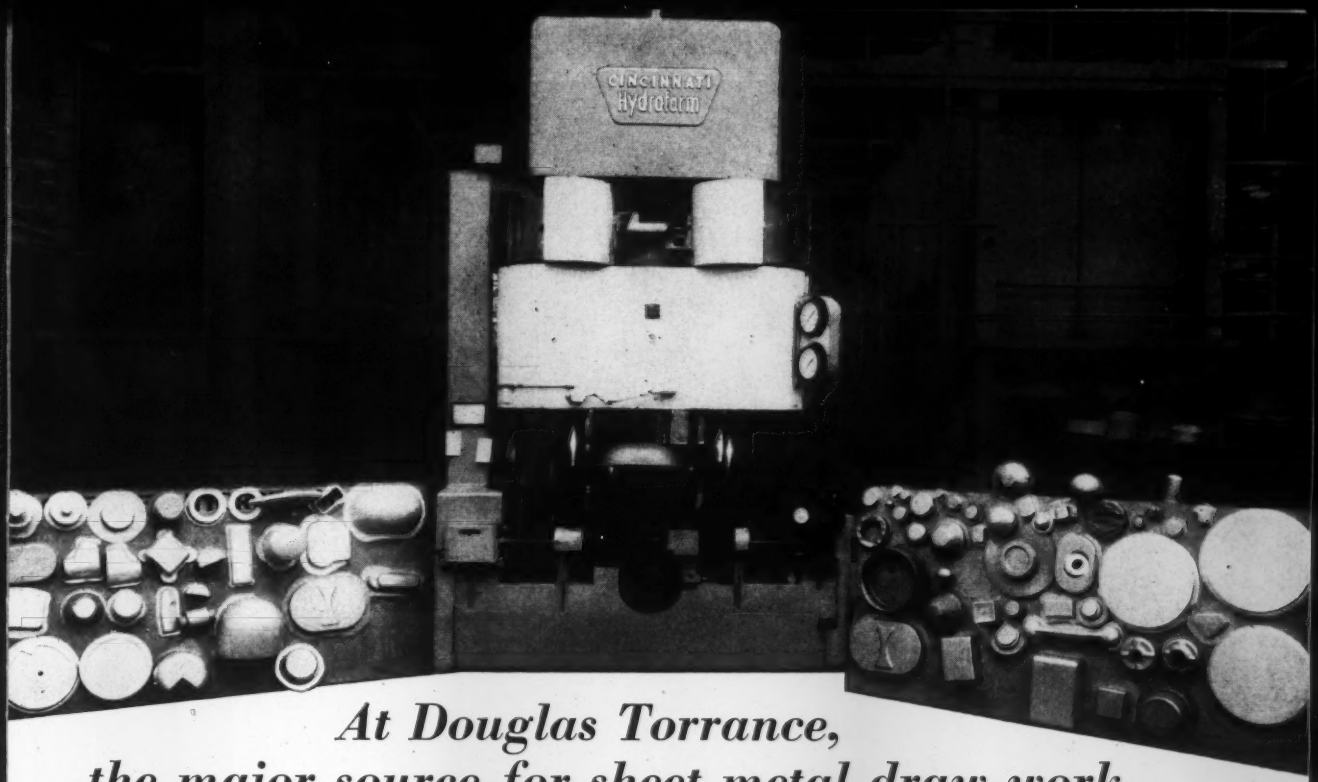
The most resistant material tested was Haynes 25; the least resistant was A-286. None of the alloys showed pitting or stress corrosion cracking after immersion in de-ionized water.

All three materials are being considered for use as springs in the coolant system of a nuclear reactor.

Test results

Haynes 25 had about 85 to 95% less corrosion than the other two materials after immersion in high temperature water. The alloy reached a steady-state rate of corrosion in about one week, whereas the other two alloys corroded at a relatively high rate for approximately one month before reaching a steady-state rate of corrosion (see graphs). The alloy corroded more in air-saturated

* The authors are associated with Knolls Atomic Power Laboratory, Schenectady, N. Y., operated for the Atomic Energy Commission by General Electric Co.



At Douglas Torrance, the major source for sheet metal draw work is the **Cincinnati** Hydroform

The state of Hydroforming art at the Torrance facility of Douglas Aircraft Co., Inc., El Segundo Div., has progressed to the point that their 26″ Hydroform® is the major source for sheet metal draw work. The photo above shows their Hydroform, surrounded by display panels of typical parts produced. These display panels are kept at the machine site for the edification of visiting tooling and methods engineers. Note the variety of complex shapes and the extreme range of part sizes, all produced on this machine.

Many parts formerly fabricated by welding and hand finishing, or produced by drop hammer, conventional deep drawing, or spinning, are now Hydroformed complete in one or two draws. Improved part quality, and incalculable savings in tooling and labor costs, scrap loss and production time have resulted.

Look into the many advantages offered by Hydroforming for producing your sheet metal parts and components. For full information, call in a Meta-Dynamics Division field engineer.

Hydroform

META-DYNAMICS DIVISION
Machines for Metal Forming and Heat Treating

THE CINCINNATI MILLING MACHINE CO.
Cincinnati 9, Ohio, U.S.A.

CINCINNATI

For more information, circle No. 365

Small shapes are drawn on the 26" Hydroform at Torrance, by using the ingenious multiple punch and draw ring set shown below. This tooling is used for the simultaneous forming of up to four parts, or for the production of unusually small parts. The main draw ring (Fig. 1) will accept insert-type draw rings, and punches up to 3", 4", 5" and 6" in diameter. Fig. 2 shows a right-hand and left-hand part punch, and draw ring, ready for insertion in the tool set. Tools can be changed in two minutes. Fig. 3 shows the parts produced.

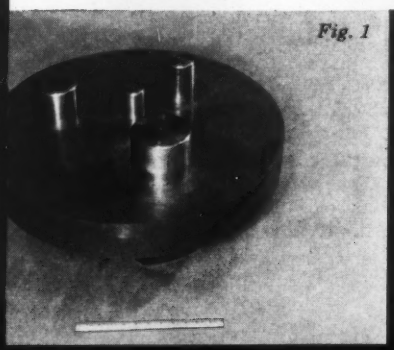


Fig. 1

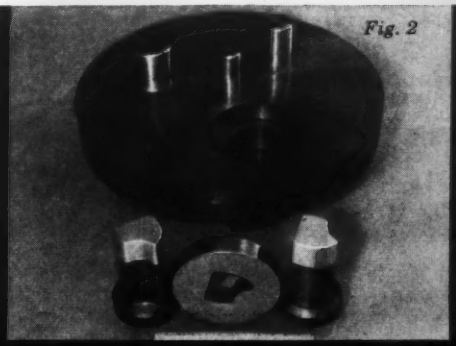
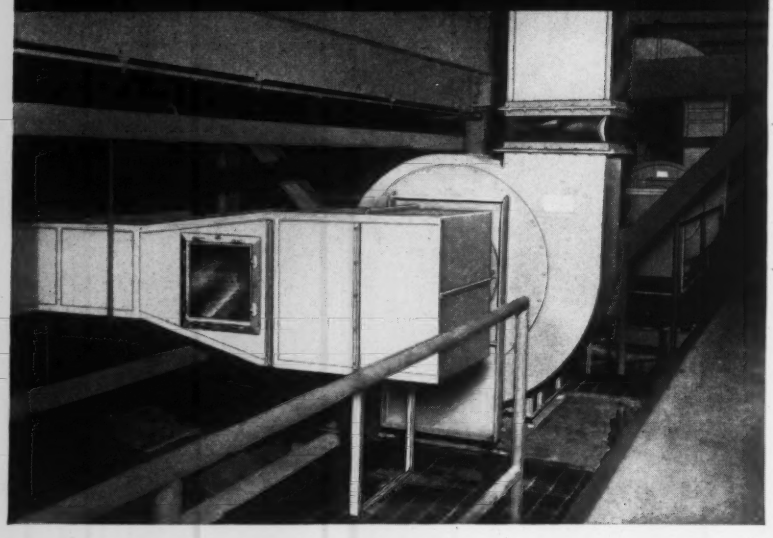


Fig. 2

Fig. 3

problem: **Corrosive Acid Fumes**

solution: **Van-Cor Exhaust Duct System**

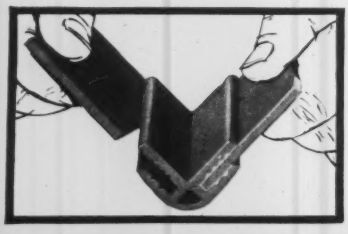


OVER 50,000 SQ. FT. OF VAN-COR SHEET AND JOINING STRIPS remove all acid, plating and cleaning fumes throughout the Allentown (Pa.) Works of Western Electric Co. Corrosion is stopped in its tracks because Van-Cor unplasticized PVC is resistant to scores of acids, alkalies and salts.

Although the contractor was unfamiliar with plastics fabrication, he was able to assemble the components of this system on the job site at a substantial savings over installation of prefabricated components. This savings was made possible through the use of Van-Cor joining strips.

VAN-COR FABRICATIONS, PIPE, FITTINGS, VALVES, CONDUITS offer *you* these advantages:

1. *Resist Corrosion of Industrial Acids & Alkalies*
2. *Light in Weight (½ that of Aluminum)*
3. *Easily Installed; High Tensile Strength; Low Flow Resistance*
4. *Readily Formed, Machined, Threaded and Welded*



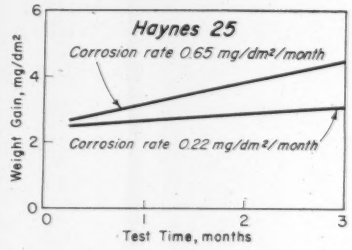
Van-Cor 90° and H Joining Strips
The fast, low-cost way
to connect PVC sheet stock.

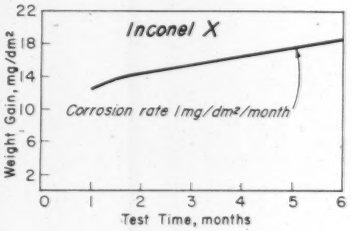
Write for Catalog and Name of Nearest Distributor

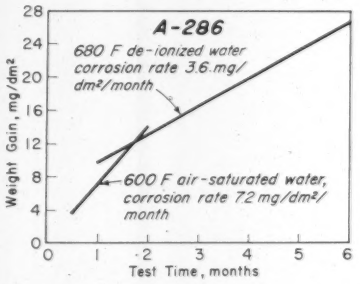
INDUSTRIAL DIVISION OF...
COLONIAL PLASTICS MFG. CO.
Subsidiary of THE VAN DORN IRON WORKS CO.
2685 EAST 79TH STREET CLEVELAND 4, OHIO

For more information, turn to Reader Service card, circle No. 395

What's new IN MATERIALS






A-286
680 F de-ionized water corrosion rate 3.6 mg/dm²/month
600 F air-saturated water, corrosion rate 7.2 mg/dm²/month
Weight Gain, mg/dm²
Test Time, months

Corrosion *of spring materials in high temperature, de-ionized water.*

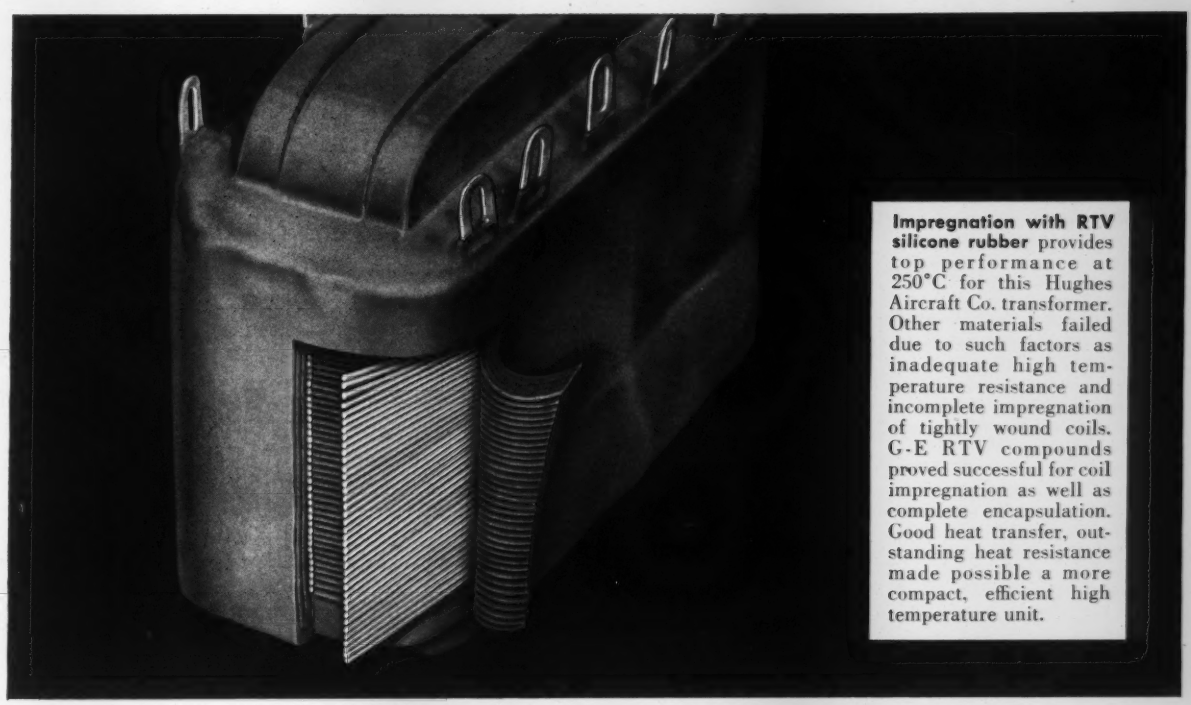
water than in de-ionized water. Shot peening decreased the corrosion resistance of the alloy.

Inconel X formed a slightly thicker corrosion product than the cobalt-chromium-tungsten alloy. The presence of dissolved air in the water seems to produce a darker and thicker corrosion product on this alloy. Dissolved air severely corroded both chromium and cobalt-tungsten electroplates on the end turns of the nickel-chromium-iron springs.

A-286 had a weight change rate almost four times grater than that of the nickel-chromium-iron alloy after exposure to 680 F de-ionized water. The presence of dissolved air doubled the rate of corrosion in 600 F water.

How tests were performed

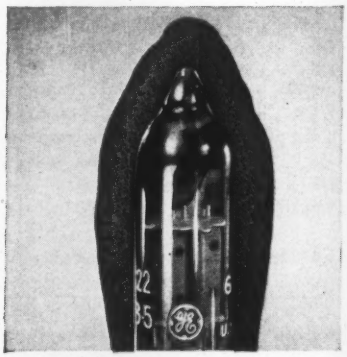
The corrosion tests were performed by exposing helical springs made of the three materials to 600 and 680 F



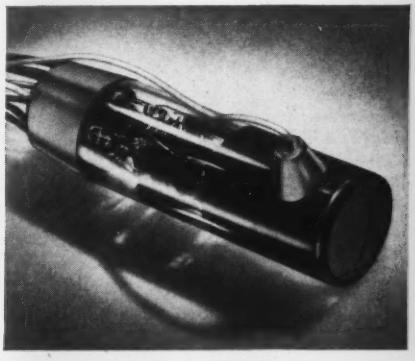
Impregnation with RTV silicone rubber provides top performance at 250°C for this Hughes Aircraft Co. transformer. Other materials failed due to such factors as inadequate high temperature resistance and incomplete impregnation of tightly wound coils. G-E RTV compounds proved successful for coil impregnation as well as complete encapsulation. Good heat transfer, outstanding heat resistance made possible a more compact, efficient high temperature unit.

Added protection, easier application with General Electric RTV silicone rubber insulation

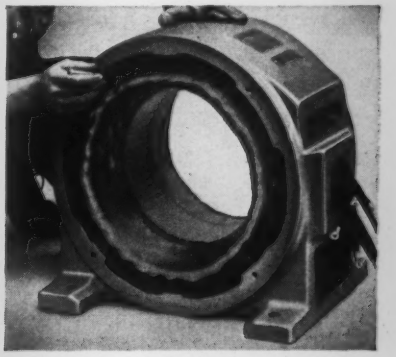
Outstanding heat resistance and electrical properties combined with room temperature cure



New resilient, shock-absorbent RTV sponge offers improved shock and vibration protection at elevated temperatures; permits easier fabrication than previous methods of cutting, inserting and sealing sponge in place. With RTV, just add sponging and curing agents to compound and mix.



Protection from high altitude arc-over and corona is provided for this cathode ray tube by encapsulating all lead wires with RTV (room temperature vulcanizing) silicone rubber. Designed for airborne operation and installed in a non-pressurized section of the aircraft, tube is protected from arc-over and corona at altitudes up to 70,000 feet.



Extended service life for motors through RTV encapsulation of stator windings, introduced by General Electric motor departments. RTV's resistance to moisture and other contaminants enables these dripproof motors to meet certain applications formerly requiring totally enclosed units. RTV has low viscosity, rapid cure.

For application data and samples of General Electric RTV silicone rubber, write General Electric Company, Silicone Products Department, Section B108, Waterford, New York

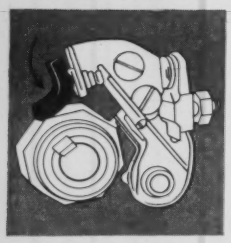
GENERAL ELECTRIC

Silicone Products Department, Waterford, New York

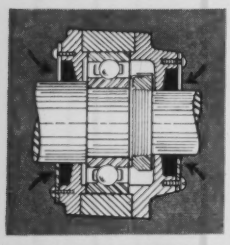
For more information, turn to Reader Service card, circle No. 549

How
FELT
BY FELTERS
Can Improve Product
SEALING and LUBRICATION

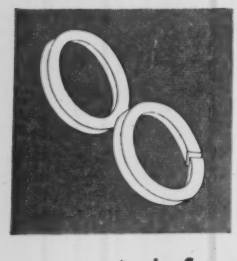
DuFelt is a laminated combination of Felters' felt and Hycar; and is recommended for sealing of lighter oils when no head exists. Seals and lubricates at the same time; and offers improvements over other materials.



Felt is an ideal wicking and lubricating material which can be designed into special assemblies like this distributor cam shown here. Lubrication is constant, wear reduced, and felt can be shaped to cover all required areas.



Lifetime bearing lubrication is now possible by selection of correct SAE grade, and designing into sealed bearing. Felt filters out contamination and works as combined reservoir and wick, directing oil flow to required areas.



Mechanical felt seals permit a close seal without undue pressure. Felt can be waterproofed and provides superior grease and oil retaining and dust, dirt and grit exclusion.

To help you get the most out of FELT, send for the Felters' Design Book. Write, today.

FC 9-18

Ask for **FELT** *from . . .*

The **FELTERS** Co.

220 SOUTH STREET
BOSTON 11, MASSACHUSETTS

Pioneer Producers of Felt and Synthetic Non-Woven Fabrics

For more information, turn to Reader Service card, circle No. 507

de-ionized water (degassed or air-saturated) for periods up to six months. The water was prepared by passing it through a de-oxygenating and de-ionizing resin.

The springs were pickled, weighed and tested under stress fully immersed in the water. Periodically, three specimens were removed and reweighed to determine the total amount of corrosion after each test period.

The springs were stressed by compressing them between stainless steel washers with a stainless steel nut and bolt. The desired load for a particular stress level was obtained by placing lead weights on top of the springs. In general, 3 to 12 springs were tested simultaneously.

Silicone Sponges for Cushioning, Damping

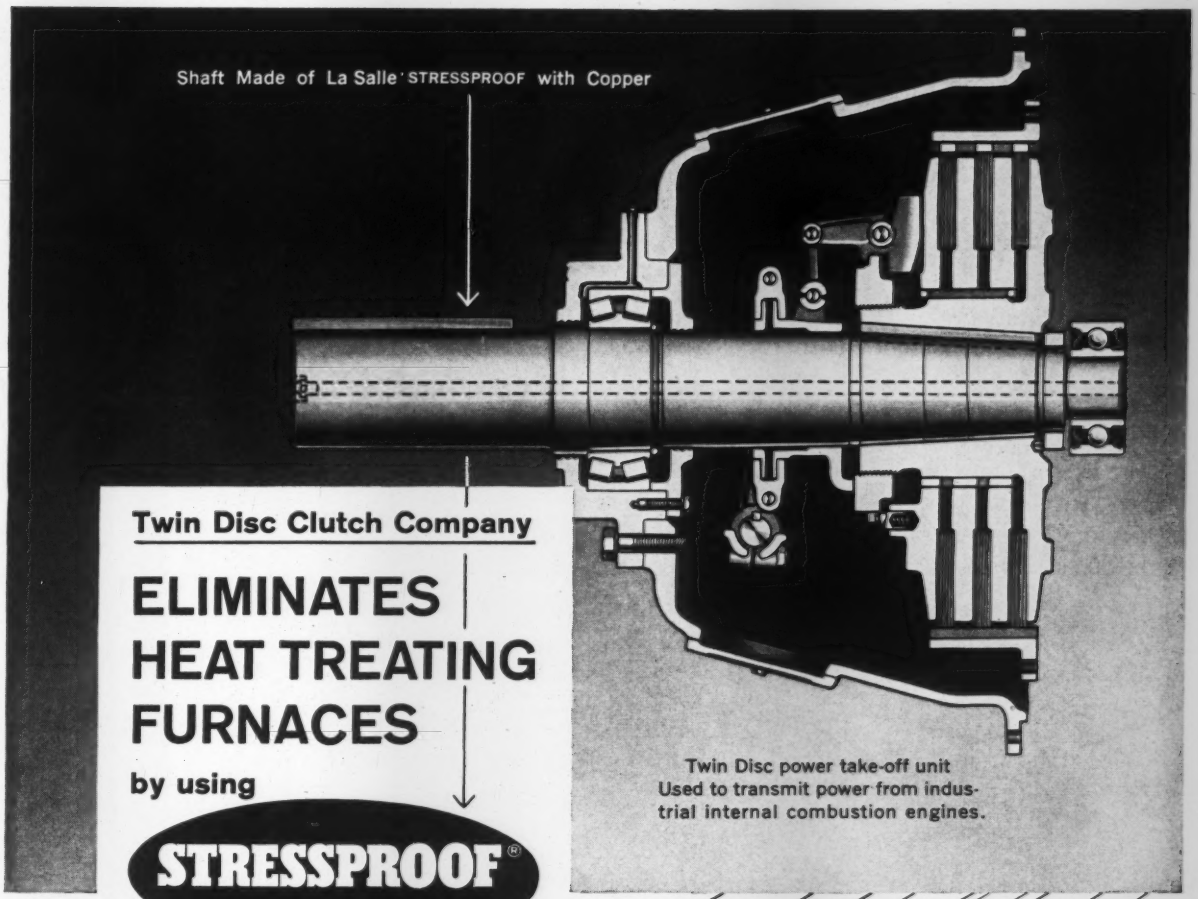
Two compounds have been added to the growing family of RTV (room temperature vulcanizing) silicone rubbers available from the Silicone Products Dept. of General Electric Co., Waterford, N. Y. (For information on two other RTV silicone rubber compounds, see M/DE, Mar '58, p 4.)

Both of the new compounds are said to cure at room temperature in a few minutes to form a resilient, silicone sponge rubber. They are designed for such applications as

PROPERTIES OF SILICONE SPONGE RUBBERS

Type →	120	160
PHYSICAL PROPERTIES		
Specific Gravity, lb/cu ft	31-44	37-50
Cell Structure	Closed	Closed
Weight Loss (24 hr at 80 F), %	1.9	1.6
ORIGINAL MECHANICAL PROPERTIES		
Compression-Deflection (25% compr), psi	28	31
Resiliency (Bayshore), %	60-70	65-75
AFTER AGING 24 HR AT 400 F[a]		
Compression-Deflection (25% compr), psi	24	32
Resiliency (Bayshore), %	65-75	65-75

[a]Cured 24 hr at room temperature.



Twin Disc power take-off unit
Used to transmit power from industrial internal combustion engines.

Twin Disc Clutch Company

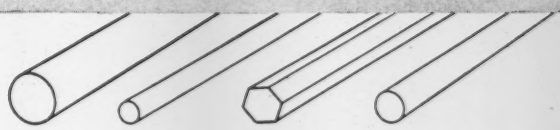
ELIMINATES HEAT TREATING FURNACES

by using

STRESSPROOF®

with copper

STEEL BARS



In Racine, Wisconsin, Twin Disc Clutch Co. saved money on a plant addition by eliminating heat treating furnaces . . . and they continue to save on part costs by using a material which needs no heat treatment . . . STRESSPROOF.

On the strength of over 15 years' experience with STRESSPROOF, Twin Disc knew they could cut their costs by purchasing this material which has the necessary properties in the bar.

They produce about 150 different models of power take-off shafts . . . see cross-section drawing. These shafts must possess great toughness and have the strength to take heavy loads. They must resist wear at the journals. Because one end of each shaft must be machined to individual customer specifications, machinability is important. Warpage after machining cannot be tolerated.

STRESSPROOF with copper fills these requirements on all counts because it has these four qualities in the bar: (1) Strength without heat treating. (2) Machinability (copper further improves machinability). (3) Excellent resistance to wear. (4) Minimum warpage.

By using STRESSPROOF, Twin Disc eliminates the cost of heat treating, cleaning and straightening. Working conditions are better . . . the plant is cleaner and cooler, and floor space requirements are less. Time and money consuming production steps are eliminated.

Twin Disc gets better parts at lower cost, and perhaps you can profit by their experience. Unless you have investigated STRESSPROOF recently, you may be overlooking worthwhile savings, especially since copper has now been added to improve machinability.

Available from your Steel Service Center.

La Salle STEEL COMPANY

1418 150th Street, Hammond, Indiana

Please send literature describing La Salle STRESSPROOF with copper.

name_____

title_____

company_____

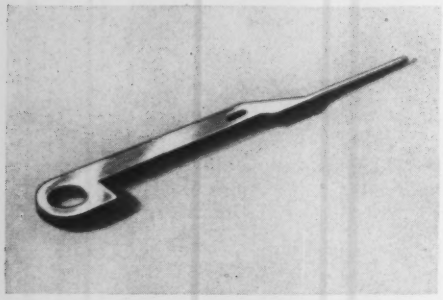
address_____

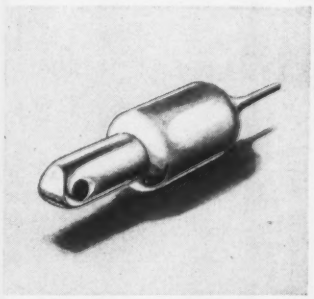
city_____ zone_____ state_____

For more information, turn to Reader Service card, circle No. 504

NEWS
from Torrington on
SMALL PRECISION METAL PARTS

"Custom manufacture" need not be costly—at least, as practiced at Torrington's Specialties Division. Our engineers, experienced in a multitude of methods and operations, have a knack for fitting the most efficient techniques to any small metal part in question. And these methods are not necessarily the most obvious. The motto might well be, "Precision at any cost—so long as it's the *lowest* cost possible!"

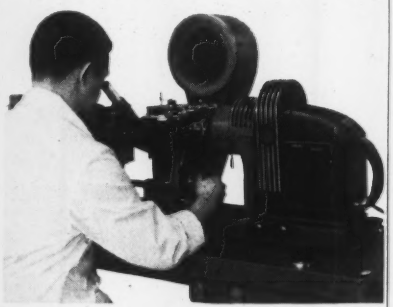




Take the control pin and sensing pin we make for a leading business machine manufacturer. Diameter of the circular section must be held to .001". Other critical dimensions require as stringent tolerances. Torrington selected a combination of stamping and swaging operations as most economical and efficient. High accuracy is achieved without tool marks or stress concentration points. Parts are tempered to RC 52-54, and are accurate to required tolerance *without grinding* and have a better finish than grinding would produce!

Then there's the pin we make for an aircraft application. Made of 440C stainless—a difficult material to work—it is finished to 8 micro-inches, again without grinding. The three radii are held concentric to .006". After tempering to RC 52-60, the part is given a .0002 to .0004" hard chrome plate.

Part of the perfection of the finished unit is the quality of material used. Skilled metallurgists have access to the most modern laboratory equipment to make sure materials meet your drawing specifications. We maintain three separate heat-treating departments, each with equipment selected for specific types of parts or materials involved. Statistical quality control methods insure the quality of product you specify. For help with



your large quantity requirements of small precision metal parts, just circle our number on the reply card, call our area salesman, or write direct to:

The Torrington Company, Specialties Division, 777 Field Street, Torrington, Conn.

TORRINGTON SPECIAL METAL PARTS

Makers of Torrington Needle Bearings

For more information, turn to Reader Service card, circle No. 380

void filling, cushioning and vibration damping.

The two compounds are identified as RTV-120 and RTV-160. The primary difference between them is the degree of resiliency; RTV-160 is designed for applications requiring somewhat greater resiliency than that offered by RTV-120.

Grease Resists Water, Gasoline, Solvents

Anderol L-237 is the name given to a new synthetic grease designed for use in applications where the grease must be completely resistant to gasoline, solvents and water. The material is also said to withstand temperatures from –20 to 300 F.

It is available in 1 and 5-lb cans, and in drums up to 400 lb, from Lehigh Chemical Co., Industrial Lubricants Div., Chestertown, Md.

The new material is said to seek out metal and cover it with a film that acts as a protecting seal against humid and salt conditions. The grease is expected to find use in fuel systems, couplings, plug valves, fuel pumps, gate valves, missiles, bulk oil plants and flight refueling systems.

Sintered Tungsten Is Readily Forged

Pure tungsten and tungsten alloys, heretofore virtually impossible to fabricate, are now available in preformed shapes and ingots that can be readily forged into finished pieces at 3400-3500 F. The preformed shapes, which are hollow, are supplied in conical and cylindrical shapes in sizes up to 8 in. in dia by 4 in. long. Ingots are supplied in sizes 4½ in. in dia by 12 in. long.

The tungsten parts are made forgeable by new vacuum sintering techniques developed by Firth Sterling Inc., 3113 Forbes St., Pittsburgh 30. The company reports that equipment is now being designed and constructed to produce ingots of pure tungsten 10 in. in dia by 20 in. long. These large ingots will weigh 1100 lb.

(Fansteel Metallurgical Corp. recently announced the development of

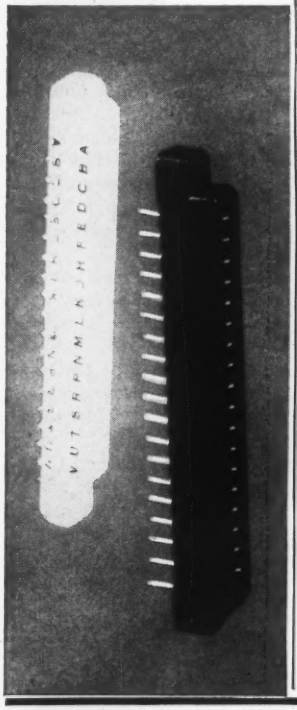
Plaskon Nylon News

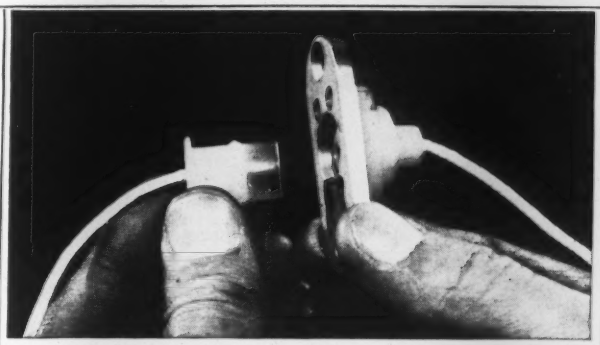
Type 6 • Nylon's Range of Applications Expands!

MORE AND MORE INDUSTRIAL AND CONSUMER PRODUCTS MAKE USE OF ITS OUTSTANDING PROPERTIES

Durable Electrical Circuits

Space Products, Long Beach, Calif., uses flexible Plaskon Nylon 8200 for circuit connectors because it produces higher uniformity of finished parts yet lowers manufacturing costs. These "Ezi-Connectors" feature beryllium contacts, with a fatigue resistance twice as great as that of spring brass or phosphor bronze. They are moisture-proof and can be easily and repeatedly inserted and removed. Available in several colors, they are lettered to permit easy assembly and identification.





Reliable Missile Fire Connector

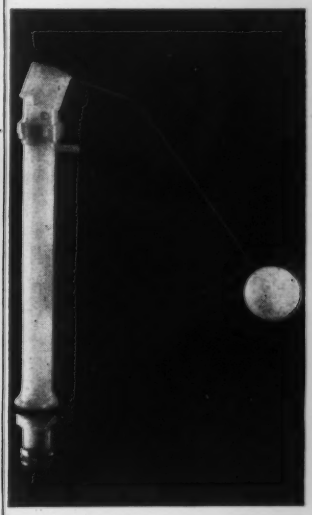
Plaskon Nylon 8200's outstanding durability, light weight and resilience are put to good use in this missile fire connector. Injection molded nylon provides excellent insulation and seal against contaminants and moisture for the connector's contacts, as well as mechanical protection for the unit itself. The manufacturer, Alden Products, Brockton, Mass., reports that Plaskon Nylon 8200 enables him to achieve the highest compactness and reliability for this vitally important missile component.

High Strength Closures

This smooth, lustrous Plaskon Nylon cap nut will not scratch, snap or tear other surfaces as do metal caps. Ideal for use in the furniture and electronics industries, the "Relok" Nut is rust-proof, antimagnetic and self-locking. Plaskon Nylon's high strength and impact resistance enable it to withstand rugged duty. The Lehigh Metal Products Company, Cambridge, Mass., supplies the "Relok" Nut in several lengths and colors.

Superior Ballcock Valve

The Hydo Valve Corporation, Austin, Texas, manufactures this ballcock toilet valve with injection molded Plaskon Nylon 8200. The valve's superior action cuts water closet fill time in half and eliminates noise and seepage. Plaskon Nylon is ideal for products of this type because of its high resistance to heat, chemicals and abrasion. Also, nylon's light weight produces a more compact unit, which can be more economically stored and shipped.



Extra Extrusion Economy! Plaskon Nylon Extrusion Compound 8205 maintains high-melt viscosity through successive regrinds. Scrap can be re-extruded several times without the slightest deterioration of basic properties.

FOR FURTHER INFORMATION OR TECHNICAL ASSISTANCE, WRITE TO OUR NYLON PRODUCT DEVELOPMENT DEPARTMENT.

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What's new IN MATERIALS

Forged tungsten shape *can be machined with conventional carbide tools.*

new hot working techniques for forming, spinning, forging, extruding, and drawing tungsten; see M/DE, June '59, p 74.)

Small Rubber Parts for Electronic Devices

A new rubber company (formed in 1958) has developed methods for the mass production of "microminiature" rubber parts for electronic devices. Rubber bushings as small as 0.050 in. o.d. x 0.050 in. high with a center hole of 0.012 in. are currently in production.

The small parts are used as end seals for microminiature tantalum capacitors. The company, Industrial Electronic Rubber Co., 31945 Aurora Rd., Solon, Ohio, says it is tooled to produce 1,000,000 such parts a month.

The company uses a wide range of elastomeric materials, including Kel-F Elastomer and Viton A, for its line of electronic rubber parts. The compounds are said to be carbon and sulfur-free to permit use in thin insulating and gasketing applications without risking current leakage, silver tarnish or outgassing.

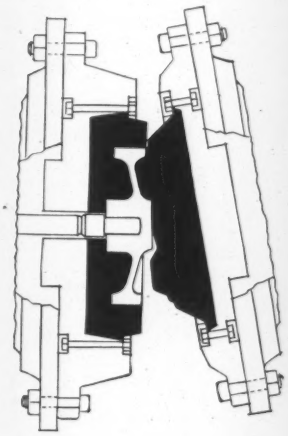
New Developments in Powder Metallurgy

Four recent developments in the field of powder metallurgy are: 1) coated metallic and nonmetallic powders; 2) improved atomized metal powders; 3) a new method for compacting metal powders into con-

Unique Mill Forges and Rolls circular products in one operation

In less than one minute, this Bethlehem mill—the only one of its kind in the country —turns out a top-quality impression-die steel forging at a cost that's hard to match.

This is Bethlehem's famed circular-products mill—the Slick Mill. Named for its designer, Edwin E. Slick, this unique machine produces impression-die circular forgings ranging from 10 in. to 46 in. OD; as-rolled weights ranging from 100 to 2,000 lb. It handles almost any grade of steel—carbon, alloy or stainless, as well as certain heat-resistant grades.

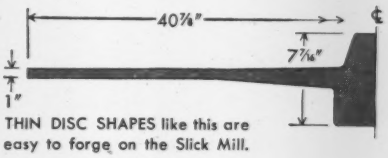


How It Works

Designed to operate in a horizontal plane, Bethlehem's Slick Mill is constructed with two *revolvable* spindles on which face plates are mounted. These face plates support the impression dies that form the steel billet into shape by a combination press and rolling action.

After the steel billet is heated and descaled, it is centered between the dies of the Slick Mill. Then a 1500-ton hydraulic ram actuates the spindle on the straight side of the mill, upset forging the billet. When this cycle is completed, a 2,000-hp motor actuates the spindle on the angle side of the mill and the rolling cycle begins. By continuing the upsetting action and rotation of the dies and work, the material flows into the recesses of the dies, resulting in the desired shape. *The entire rolling cycle takes about one minute.*

After rolling, excess material in the form of flash is sheared off; the hub, when necessary, is punched; and the forging is inspected.



THIN DISC SHAPES like this are easy to forge on the Slick Mill.

Cost-Saving Features

Quick operation: Only one minute is needed to convert a heated slug into a contoured forging, whether the product weighs 100 or 2,000 lb.

Quick die changes: Only 15 minutes are needed to change and set up dies. Even production runs as small as 25 or 50 pieces are economical.

Low die charges: Since contact time between die and work is very brief, and because there is no impacting, low-cost die blocks can be used. In many cases, die charges are ⅓ to ½ less than conventional impression dies.

Less steel needed: Utilizing the principle of forging design, the Slick Mill can produce lighter-weight sections without sacrificing strength.

Good physical characteristics: The process insures excellent grain flow, machinability and soundness.

Bethlehem's Slick Mill is readily adapted to jobbing or production quantities of forged circular products such as: gear blanks, fly wheels; crane track wheels; sheave wheels; brake drums; clutch discs; couplings; tire moulds; and turbine or compressor wheels. Products may be specified as-rolled or rough machined to specifications.

Your inquiry—whatever the quantity involved—will receive prompt attention. Call or write the Bethlehem sales office nearest you today.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

Export Distributor: Bethlehem Steel Export Corporation

BETHLEHEM STEEL

BETHLEHEM STEEL

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UTMOST DIMENSIONAL STABILITY*

Almag 35 is a high purity aluminum-magnesium alloy possessing exceptional dimensional stability properties, which fully assure the finest castings with all the following advantages:

- High strength
- High shock resistance
- High corrosion resistance
- High ductility
- No age hardening
- Superior machineability
- Takes high polish
- As cast without heat treatment no locked up stresses

Covered by U.S. Patents 2564044, 2568179, 2628899, 2764482, 2568180, 2584772, 2733991 and 2583473. Do not accept substitutes.

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*Stabilization at 700°F provides absolute stress relief without loss of properties or machineability.

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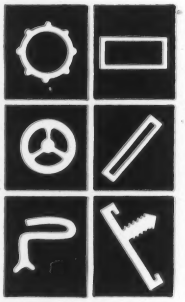

We extrude any shape in a variety of formulations to meet a wide range of design and performance requirements. Our complete tool and die shop is staffed with skilled technicians. We maintain a library of more than 400 section dies, one of which may fit your product design.

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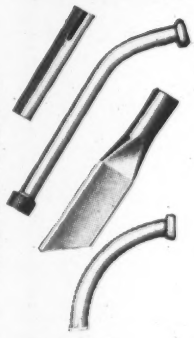

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tinuous bars; and 4) an improved sintering method for brass powders.

1. Coated powders

Coated metallic and nonmetallic powders now emerging from the laboratory may fill the need for new materials in nuclear fuel elements, aircraft, missiles and electronic devices, according to J. H. Oxley and J. M. Blocher, Jr. of Battelle Memorial Institute.

The two scientists, writing in the July '59 issue of the *Battelle Technical Review*, describe a wide range of coated powders that can now be made by a fluidized-bed, vapor deposition process which they have been studying. In this chemical process, a thin metallic or nonmetallic film is deposited on powders placed in a chamber containing a vaporized coating material.

The scientists believe that substantial contributions can be made in the field of nuclear technology by using precoated powdered nuclear fuel elements. Advantages outlined for the fuel elements include 1) an increase in thermal conductivity, 2) improved fission-product retention, 3) avoidance of interaction between the fuel materials and other materials in the reactor, 4) superior strength, and 5) deposition of burnable poisons on the powdered fuel. (Burnable poisons are neutron absorbers that gradually disappear with continued radiation.)

Another application for coated powders is in aircraft and missiles. Coated powders could be used as a lightweight material of construction for use at elevated temperatures under oxidizing conditions. For example, less oxidation-resistant powdered materials could be coated with thin films of platinum or platinum alloys and fabricated into the desired shape by powder metallurgy techniques. Any failure of the initial surface of the precious metal alloy, because of melting, erosion or other mechanical phenomenon, would be localized. The oxidation resistant matrix material would limit this penetration of the surface to a depth equal to the diameter of the original starting powder.

A powdered material coated in a protective matrix could be selected on the basis of properties quite apart from oxidation resistance, such as

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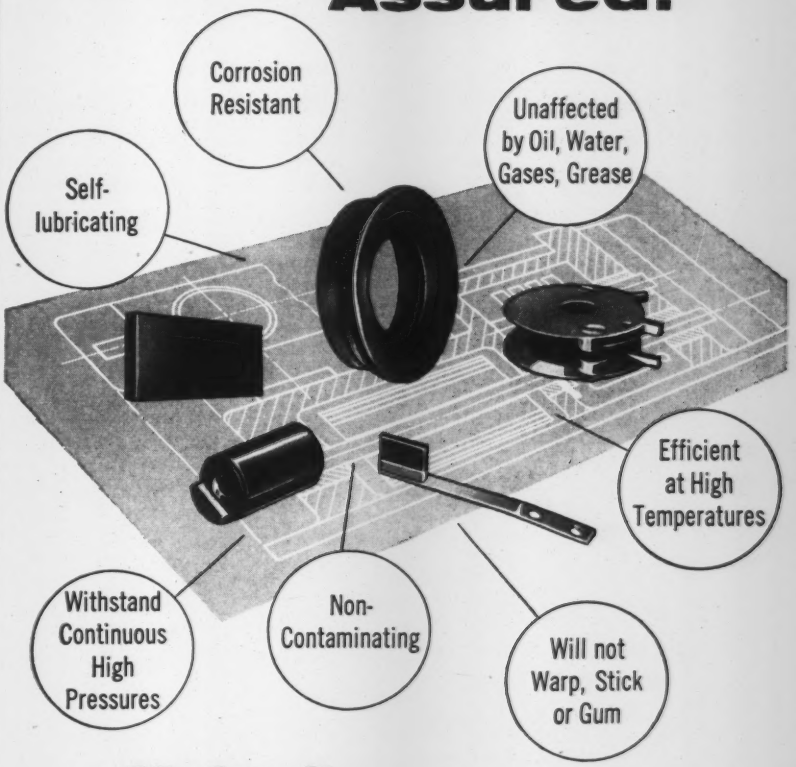

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Morganite has the answer to countless hard-to-solve design considerations. Its many inherent electro-mechanical advantages afford engineers extremely wide latitude and a high degree of flexibility. For example, self-lubricating Morganite bearings are ideal for incorporation in sealed mechanisms. Radar contacts of Morganite are employed in critical military and commercial systems because of exceptional dependability over a wide range of temperatures. For suggestions on your design problems, just call or write, Morganite!

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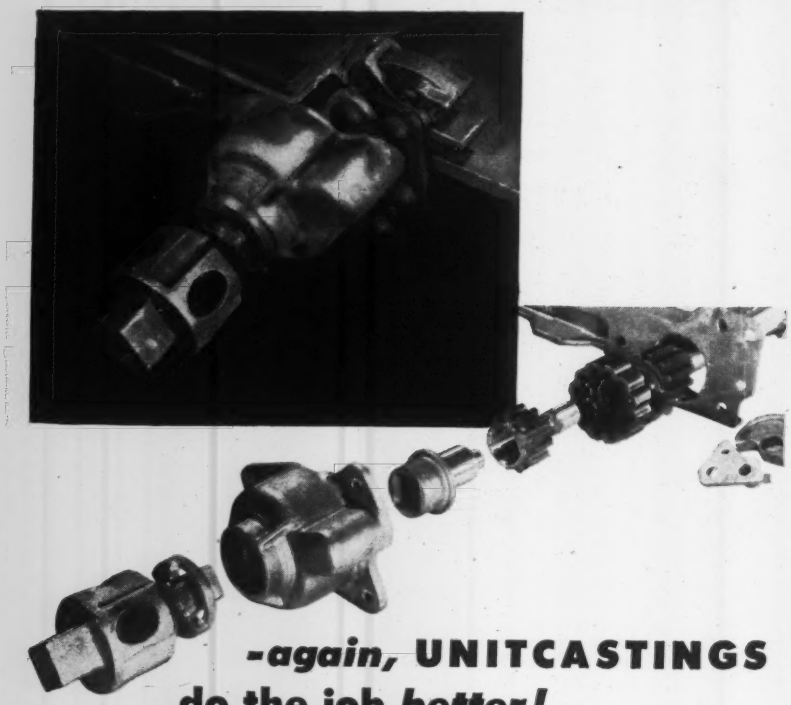
Progressive Foundry Engineering Develops Accurate Components . .



-again, UNITCASTINGS do the job *better*!

Unitcast foundry technicians, working hand-in-hand with customer's engineers, match new processes and developments with new steel casting demands.

The close tolerance requirements of this new horizontal gate mechanism proved a challenge. Designed around a new hypo-cyclic gear to reduce operating effort 80%, finished costs had to remain competitive. Each component was delivered to finished size with only touch up grinding necessary before assembly, and a high quality, durable product was marketed with the benefit of cast steel.

Unitcast offers similar service to help you with close tolerance, cost reducing problems. Write or call today for complete information.

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SPECIFICATION STEEL CASTINGS

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What's new IN MATERIALS

light weight, high heat capacity, high strength, high melting point, high effective thermal conductivity, or the ability of the material to undergo a heat absorbing reaction at intermediate temperature levels.

2. Improved atomized metal powders

Federal - Mogul - Bower Bearings, Inc., 2355 W. Stadium Blvd., Ann Arbor, Mich. has developed a new metal powder atomization technique that is said to produce exceptionally clean, fine, specifically-shaped pure or alloy metal powders.

Metals that can be produced by the new atomization process include: iron, monel, the 300 and 400 series of stainless steels, manganese-nickel alloys, manganese-nickel-chromium alloys, cobalt-base alloys, nickel, silver, silver-lithium alloys, silver-magnesium alloys, nickel-chromium alloys, silver-nickel alloys, aluminum, aluminum-tin alloys, aluminum-magnesium alloys, copper, copper-nickel-zinc alloys, copper-nickel-cobalt alloys, copper-chromium alloys, and copper-nickel-tin alloys.

As reported in a paper by H. H. Hausner (Consulting Engineer), G. J. LeBrasse and R. L. Probst (Federal-Mogul-Bower Bearings, Inc.), atomized metal powders produce parts with equal and sometimes superior density, strength and ductility after a single sinter. This feature, the authors say, eliminates the need for any repressing, coining or resintering operations in the production of powder metallurgy products.

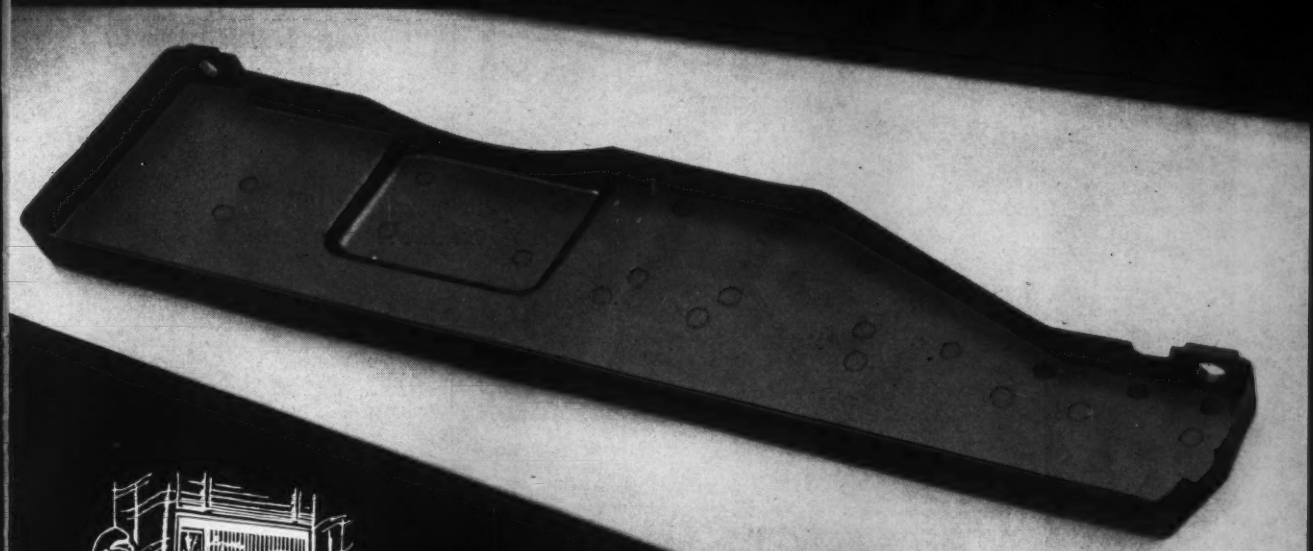
3. Continuous metallic and nonmetallic powdered bars

Metal and ceramic powdered bars of continuous length and relatively large cross-sectional area are being turned out by a new powder metallurgy technique called continuous compaction.

In the method, described by F. Emley and C. Deibel of Westinghouse Electric Corp. at the 15th annual meeting of the Metal Industries Federation, powder is compressed into continuous bars in a trough-like container by a sloping punch. As pressed powder moves out of the container, new powder enters and the cycle is repeated.

Some potential uses for the

DESIGNED IN CELANESE FORTIFLEX...



RCA WHIRLPOOL
Air Conditioner Condensate Drip Pan
Injection-molded of Celanese Fortiflex A by Metal Specialties Co., Cincinnati, Ohio for Whirlpool Corp., St. Joseph, Michigan.

Large-area injection moldings cut weight...can't rust

Good part performance dictated the selection of Celanese Fortiflex plastic for this air conditioner drip pan. Fortiflex supplied the toughness for thin-walled, lightweight construction plus corrosion resistance. Fortiflex is unaffected by hot or cold temperatures likely to be encountered in air-conditioning systems.

Fortiflex is a designer's material. Five times stiffer than conventional polyethylene, and with superior surface hardness, Fortiflex can help you meet difficult specifications and cost limitations. For more information on this versatile plastic, return coupon below.

Celanese® Fortiflex®

Fortiflex...a Celanese plastic

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For more information, turn to Reader Service card, circle No. 534

TYPICAL PHYSICAL AND CHEMICAL PROPERTIES OF FORTIFLEX

Properties of Fortiflex "A" Related to Melt Index

PHYSICAL PROPERTIES	ASTM METHOD	UNITS	FORTIFLEX RESINS A-20	A-70	A-250	A-500
Melt Index	D-1238-52T	—	0.2	0.7	2.5	5.0
Heat Distortion Temp. (66 psi)	D-648-45T	°F.	185	185	180	180
Brittleness Temp.	D-764-52T	°F.	—200	—180	—160	—100
Impact Strength, izod (⅛" x ½" injection-molded bars)	D-256-54T	ft. lb./in. notch	23	18	13	3
Tensile Strength, Max., 0.2 in./min.	D-638-52T	psi.	3700	3600	3500	3300
Elongation, First Tensile Yield Point	D-638-52T	%	25	25	25	25

Properties of Fortiflex "A" Not Affected by Melt Index

PHYSICAL PROPERTIES	ASTM METHOD	UNITS	VALUE
Density		g/cc.	0.96
Refractive Index	D-542-50	n_D^{25}	1.54
Hardness, Shore D	D-676-49T		65
Stiffness	D-747-50	psi.	150,000
Water Absorption (⅛" specimen, 24 hr. immersion @ room temp.)	D-570-54T	%, wgt. gain	<0.01
Flammability	D-635-44	in./min.	1.0
*Mold Shrinkage, length		in./in.	0.03 to 0.05
width		in./in.	0.02 to 0.04

Measured on injection molded tensile bar. Mold shrinkage depends on part design and molding conditions.

Celanese Plastics Company, a Division of Celanese Corporation of America
Dept. 102-J, 744 Broad Street, Newark 2, N. J.

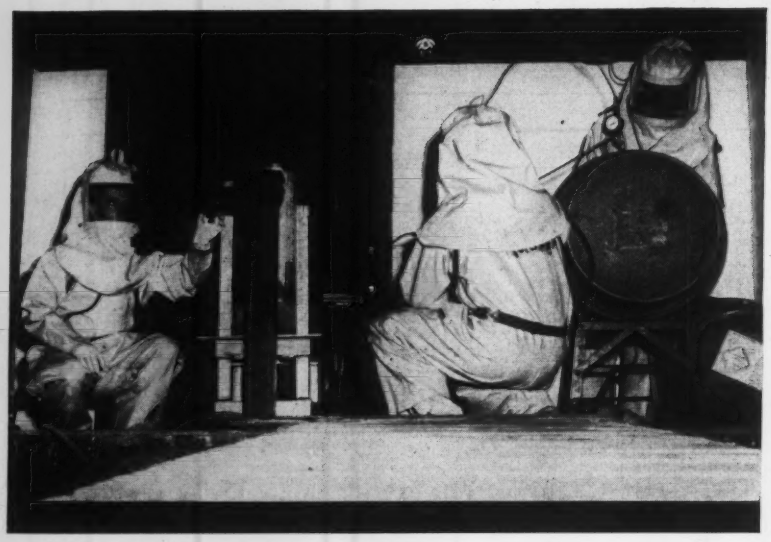
Please send: ☐ more information on, ☐ test quantities of Fortiflex.

Name_____ Title_____

Company_____

Address_____

City_____ State_____



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A MATERIALS LABORATORY than to buy one

A wealth of experience in materials evaluation . . . economical, rapid instrumental analysis . . . the latest analytical techniques as they are developed . . . all these go to work on your products and materials at United States Testing Company . . . and at a fraction of what it would cost *you* to maintain a staff and facilities.

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Typical Materials and Products Evaluated:
Adhesives—Bearings—Castings—Ceramics—Concrete—Flooring Materials—Foams—Fuels—Laminates—Leather—Molding Compounds—Paper Products—Plastics—Rubber compounds—Textiles—Water repellents and others.

Send for your free copy
of bulletin 5902 describing our materials and product evaluation facilities.

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What's new IN MATERIALS

PROPERTIES OF BRASS COMPACTS COMPARED[a]

Lubricant and Atmosphere →	Zinc Stearate, Hydrogen	Lithium Stearate, Nitrogen
Green Density, gm/cu cm	7.36	7.36
Sintered Density, gm/cu cm	7.5-7.8	7.6-8.0
Tensile Strength, psi	29,100	39,900
Elong (in 1 in.), %	11	29
Hardness (Rockwell)	H71	H78

[a]Parts sintered at 1600-1625 F under 27 tsi.

method include:

1. Fabrication of large refractory metal (molybdenum, tungsten, tantalum, etc.) sheet, strip or bar.
2. Continuous fabrication of tungsten filaments from powder.
3. Continuous fabrication of brittle metals (beryllium, etc.) into sheets, strip or bar.
4. Continuous or semi-continuous fabrication of ceramic bars, magnetic ferrites, thermal bimetals and clad reactor core elements.

4. Improved sintered brass compacts

An improved sintering technique for brass powders was outlined in a paper presented before the 15th annual meeting of the MPI. The authors, F. I. Zaleski and R. A. Powell of Frankford Arsenal, say the technique uses lithium stearate rather than the conventional zinc stearate as the lubricant during molding.

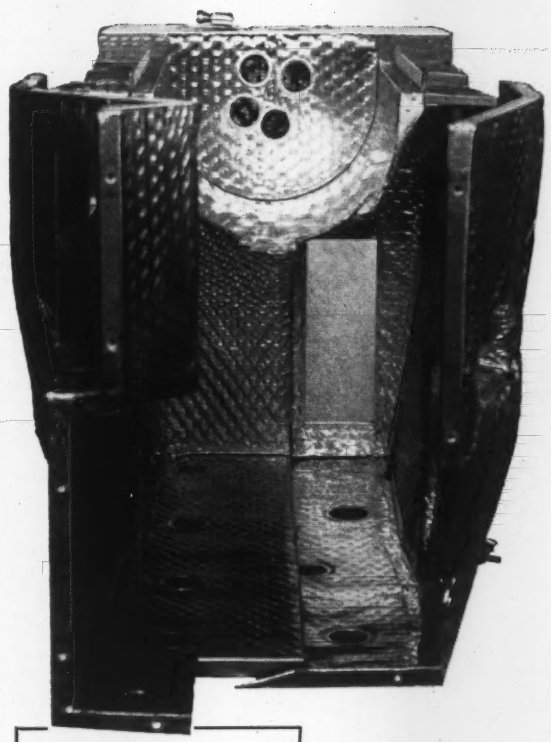
According to the authors, this new development means greater tensile strength and elongation for brass powder parts. It also means lower operating costs because of less critical atmospheres and sintering temperatures, and less expensive gas.

Preliminary studies show that improved properties can also be obtained with lithium stearate in compacts of copper and iron.

Rubber-Base Material Stops Neutron Flow

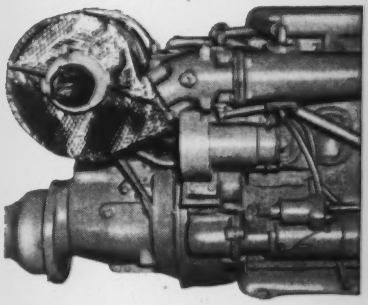
A castable rubber-base material for shielding crew and passengers from neutrons produced in nuclear powered aircraft and ships has been developed by Goodyear Tire & Rub-

Johns-Manville PRE-KLAD insulations are made possible through the company's extensive experience in fabrication and forming of thin foils.



This typical PRE-KLAD insulated housing features combination of molded parts, strengthened channel construction, close tolerance cut-outs to accommodate fittings and attachments.

Now—insulate difficult shapes in one fast operation . . .



PRE-KLAD as used by diesel engine manufacturers. Here, J-M engineers worked with customer's engineers to develop insulated blankets that readily slip over turbochargers to protect personnel and keep engine room temperature down.

Among the many PRE-KLAD applications

- Gasoline Engines
- Gas Turbine Engines
- Steam Turbines
- Heated Mechanical Equipment
- Domestic and Industrial Furnaces
- Stress Relieving Blankets
- Ingot Pads
- Heated Laboratory Equipment
- Diesel Engines, Manifolds, Turbochargers
- Home Incinerators, and other Hot Appliances
- Portable Heat Retention Equipment
- Turbogenerators
- Materials Handling Equipment
- Gear Housings
- Removable Casting and Forging Covers
- Furnace Nozzle Cones

with Johns-Manville PRE-KLAD Insulation!

New refractory fiber insulation is factory sheathed in heat-resistant foils to any required shape . . . temperatures to 2000F!

In new PRE-KLAD insulation, designers have an insulation that's right in step with efficient assembly line methods. For PRE-KLAD components arrive at your plant ready to install . . . in one fast operation!

Originally developed for jet aircraft . . . PRE-KLAD insulations are precision engineered to solve individual heat retention problems. Johns-Manville tool engineers create the special molds and dies to form the stainless steel or other thin foils into the shape you require. Then, refractory felt insulation is expertly sandwiched between inner and outer foil jackets, which are then spot- or seam-welded into a ready-to-install housing or blanket. The result is an insulating component that can be used wherever a strong, lightweight foil-protected insulation is indicated.

The insulation in PRE-KLAD is Johns-Manville CERAFELT® . . . a refractory fiber insulation that is produced by converting molten refractory materials into a mass of uniform ceramic fibers. The fine CERAFELT fibers are then felted with a minimum of binder to form an insulating material that combines lightness, heat resistance and an extremely low *k* factor.

Write today for the informative new brochure on PRE-KLAD insulations.
Address Johns-Manville, Box 14, New York 16, N. Y. In Canada, Port Credit, Ont.

JOHNS-MANVILLE

JOHNS-MANVILLE JM PRODUCTS

For more information, turn to Reader Service card, circle No. 407

This lining of TEFLON®

makes Fluoroflex®-T pipe permanently corrosion-proof

USING the pipe lining *material* that handles highly corrosive fluids is only half the job. Keeping it *in place*, despite wide temperature fluctuations, is equally important. Fluoroflex-T Type S piping solves both problems . . . assuring unequalled pipe and fitting life.

Lining is universally inert to all corrosives. It's made of Fluoroflex-T, a high density, non-porous compound* of virgin Teflon.

Liner and housing in thermal equilibrium, through an exclusive process developed by Resistoflex. It compensates for thermal expansion differential between the Teflon and housing, eliminating fatigue collapse, and cracking at the flare.

Bulletin TS-1A gives more details. Write Dept. 412, RESISTOFLEX CORPORATION, Roseland, N. J. Other plants: Burbank, Calif.; Dallas, Tex.

* *Pat. No. 2,752,637*

®Fluoroflex is a Resistoflex trademark, reg., U.S. pat. off.
®Teflon is DuPont's trademark for TFE Fluorocarbon resins.

RESISTOFLEX

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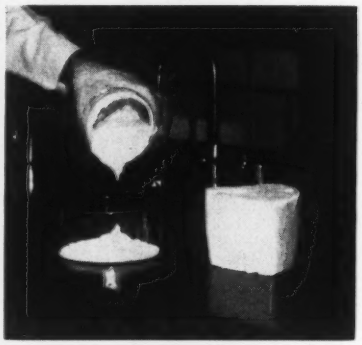
What's new IN MATERIALS



Neutron shielding rubber *might replace heavy concrete and water shields normally used in stationary atomic power units.*

ber Co., Akron 16, Ohio. Scientists at Goodyear say the new shielding is believed to be the lightest and most effective material yet developed to withstand neutron radiation.

The castable rubber, composition of which has not been revealed, contains large amounts of hydrogen to slow down neutrons. It also contains powdered metallic boron to capture the neutrons.

The material is said to withstand temperatures from –60 to 200 F. According to Goodyear, it is easy to fabricate, can absorb radiation without damage, is free from impurities, and is reasonably priced.

Asbestos, Rubber Keep Rockets Cool

A relatively low cost, asbestos-reinforced synthetic rubber insulation is said to extend the capabilities of solid propellant rocket motors for long duration, high thrust applications. The new thermal insulation was developed by Astrodyne, Inc., P. O. Box 548, McGregor, Texas.

According to Rear Adm. Paul D. Stroop, chief of the Navy's Bureau of Ordnance, the new insulation has resulted in successful test firings of solid propellant rocket motors with significant thrust levels for durations of over 3½ min. Such durations, he says, represent at least a three to four-fold increase over presently used solid propellant rocket motors which last from a few sec-

EXPANSIVITY

How Lukens *Application Research* can help you find the right steel plate for the job

In solving problems of expansivity, the experience of our Application Engineering staff is long and varied. And it's yours for the asking.

For example, a growing number of bridges expand and contract on *bearing plates* of Lukens stainless-clad steel. Extensive research led to the first such application. Tests run jointly with a consulting firm and a large university put Lukens clad steel plate through 2 million passes under a 100,000 pound loading—without harm. There was actually evidence that the bond between the backing steel and its stainless cladding grows stronger.

All the safety factors of corrosion-resistant stainless are present in stainless-clad—at significantly lower cost than 100% high alloy.

Since this initial research, many such bearing plate applications have been made—and their performance compared with that of other materials. Today, The Walt Whitman, Greater New Orleans, Rappahannock River, Throggs Neck, and a number of smaller highway bridges, are cradled on these safe, money-saving plates. The knowledge accumulated by Lukens' Application Engineers in this area and others is available to help guide you in your design problems.

That's why we say, *if your assignment is expansivity, let it be our assignment too.* Contact Manager, Application Engineering, D-109 Services Building, Lukens Steel Company, Coatesville, Pa.

Helping Industry Choose Steels That Fit The Job

LUKENS

ASK FOR THE BULLETIN ON BRIDGE BEARING PLATES

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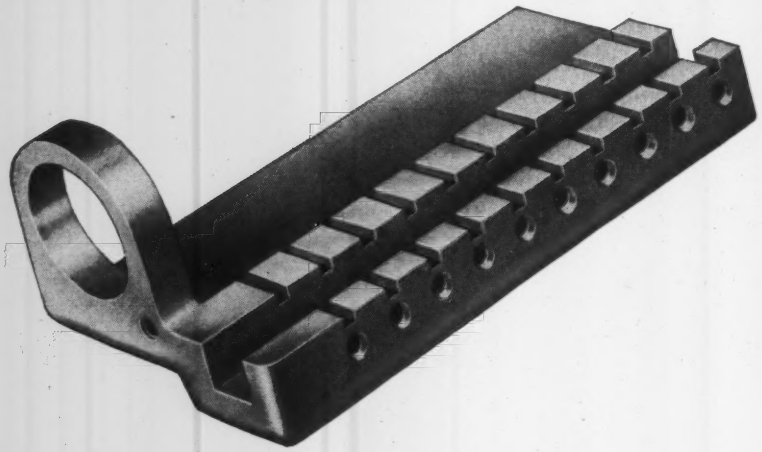

IBM *specified die casting*

...to save machining

How else could this International Business Machines part be made?

It could be milled, machined and bored. But costs would be exhorbitant. It could be cast by other methods. But accuracy and subsequent machining operations would be costly.

Look at the job! 12 cores, 10 slotted surfaces, planes on varying levels. Tolerances as exacting as ± .002, non-accumulative between holes and slots.

IBM desired to eliminate post-casting operations. Twin City Die Castings made die and castings to meet exacting requirements. Result: costs held, performance insured, the die casting process demonstrated its flexibility.

Perhaps die casting can pay you in precision, appearance, fewer assembly steps . . . by cutting your costs. Call or write. A Twin City Die Castings engineer can help die casting pay for you.

...only DIE CASTING can
✓ cut your costs ✓ offer such flexibility
✓ provide such accuracy

Leading Die Casters in the Upper Midwest

TWIN CITY DIE CASTINGS CO.

3351 TALMADGE AVE. S. E. • MINNEAPOLIS 14, MINN. • PHONE MI 6-7528

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onds to approximately 1 min.

During the rocket motor tests the insulation held the exterior of the rocket case to approximately 200 F at the end of 3½ min. Flame temperature of the solid propellant exceeded 5500 F.

Embrittlement of 6 Al–4V Titanium

When the hydrogen content of an alpha-beta titanium alloy (6 Al-4 V) exceeds 300 ppm, severe cracking (such as that shown in the accompanying photo) occurs. This fact was proved by Rod Simenz of Boeing Airplane Co. in Seattle who ran a series of sustained load tests on heat treated sheet.

Hydrogen embrittlement studied in this investigation was the type encountered at slow strain rates. Another type of embrittlement (usually found in alpha titanium) is encountered at high strain rates.

Hold hydrogen to 150 ppm

Simenz recommends that the maximum hydrogen content in titanium material specifications be held to 150 ppm. Reason: in-plant processing such as heat treatment, stress relieving, welding, annealing and pick-

Cracks in titanium structure *were caused by high hydrogen content (370 to 460 ppm), and by very high, sustained stresses induced by fabrication.*

check these cost-cutting NEW IDEAS from SETKO

then check the coupon below for full information and free test samples

IDEA #1 "NU-CUP® POINT GRIPS THINWALL TUBING BETTER THAN ALL OTHERS TESTED!"

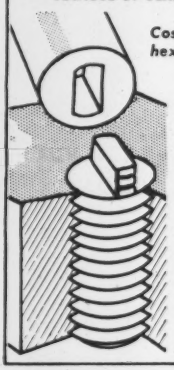
42% sharper angle on point cuts deep into the metal in a circular manner!

CONVENTIONAL

An independent manufacturer tested all types of points to find the one that would hold best . . . and perform most dependably. He chose NU-CUP. Could you use this idea? Check No. 1. (Name of Mfr. on request.)

Set Screw & Mfg. Co.

IDEA #2 THIS COST-CUTTER TAKES 50% MORE TORQUE BECAUSE OF SLABBED HEAD CONSTRUCTION!

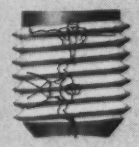


Costs less than comparable hexagon head set screws.

If you are having trouble with stripped heads or insufficient holding power, chances are the Setko Slabbed Head Set Screws are just the idea you need . . . Available in all points and metals. Check No. 2!

Set Screw & Mfg. Co.

IDEA #3 IS VIBRATION CAUSING LOOSE SET SCREWS ON YOUR PRODUCTS? . . . ELIMINATE THIS PROBLEM WITH ZIP-GRIP®!



Slight variation of thread causes locking action on mating surface!

Proven as an outstanding principle in many products, Zip-Grip has found particular acceptance wherever the stress of movement or vibration occur. Makes an outstanding adjusting screw . . . Can be reapplied many times . . . Got an idea? Check No. 3.

Set Screw & Mfg. Co.

IDEA #4 TINY SCREWS DO BIG HOLDING JOB . . . THEY'RE CALLED "MINI-MITE"

You'll find them perfectly-produced counterparts to their big brothers!

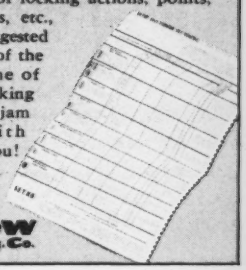
If miniaturization is one of the fields that you're interested in, then you'll see many good ideas in the perfectly-produced, money saving selection of Mini-Mites . . . Why pay for Specials when these can keep your costs at a minimum . . . Get the idea? Check No. 4.

Set Screw & Mfg. Co.

IDEA #5 NEW SELF-LOCKING SET SCREW SELECTOR CHART LISTS OVER 1,001 COMBINATIONS.

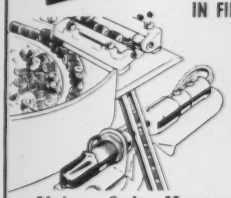
Helps you determine available combinations best for your particular application!

Here is another Setko first . . . A complete listing of locking actions, points, metals, drives, etc., including suggested applications of the complete line of Setko self-locking screws . . . It's jam packed with ideas for you! Check No. 5.



Set Screw & Mfg. Co.

IDEA #6 "SETKO HOPPER FEEDER SAVED US $42,000 IN FIRST YEAR."



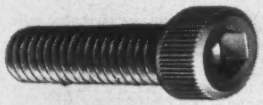
Here's the first truly Automated method of hopper feeding Headless Set Screws.

Unique Setko Hopper Feeder design orients headless Set Screws then feeds them to a driving device . . . Savings like the one shown above are but one of the advantages (name of mfr. on request) . . . Product quality is consistent, etc. This cost-cutting idea is one you can't miss! Check No. 6.

Set Screw & Mfg. Co.

IDEA #7 NOW YOU CAN GET COLD FORGED "PERFECT HOLE" CAP SCREWS IN THE NEW '60 SERIES . . .

and in STAINLESS STEEL, TOO!



If you're a user of Cap Screws you'll want to examine these yourself . . . We know you'll get our idea of trying to produce a perfect product consistently . . . We're sure you'll appreciate their performance once you've tried them . . . Would you like test samples? We'll be glad to send them! Check No. 7 and indicate sizes, etc.

Set Screw & Mfg. Co.

IDEA #8 THERE'S A BARREL-FULL OF IDEAS IN THE NEW 28-PAGE SETKO CATALOG #23.

The complete line of cost-cutting SETKO Socket Screw Products is at your fingertips.

You'll want this compact catalog for your personal use . . . And you'll particularly like the easy to read manner in which it has been prepared. Want a copy? Check No. 8.

Set Screw & Mfg. Co.

6798

Set Screw & Mfg. Co.

149 MAIN STREET, BARTLETT, ILLINOIS

Please send me Idea information on items checked below. (If FREE samples are wanted of any of these products, send your specifications).

- ☐ 1. Nu-Cup
- ☐ 2. Slabbed Head
- ☐ 3. Zip-Grip
- ☐ 4. Mini-Mite
- ☐ 5. Self-Locking Selector Chart
- ☐ 6. Hopper Feeder
- ☐ 7. Cap Screw
- ☐ 8. Catalog

NAME_____

ADDRESS_____

CITY_____ ZONE____ STATE_____

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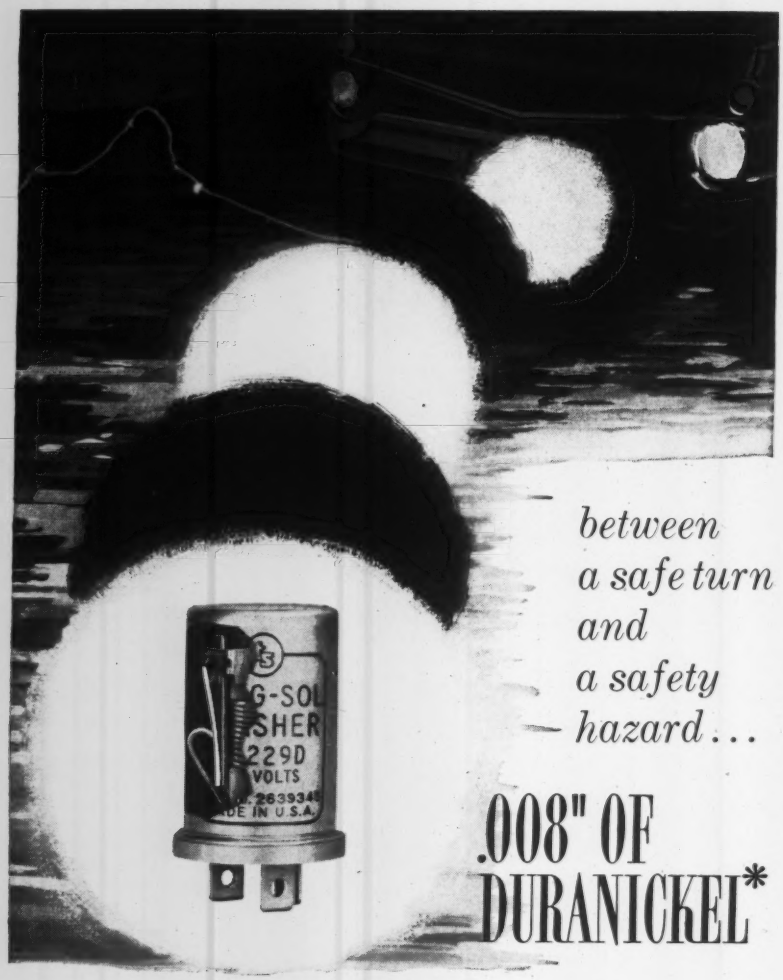

Since they first appeared in 1939, flashing turn-indicators have prevented untold numbers of accidents. The original design, developed by Tung-Sol Electric Inc., and operating today in over 50 million vehicles, relies on Duranickel from Riverside-Alloy for its life-saving dependability.

A spring lever fabricated from .008" thick Duranickel flat wire controls the on-off action . . . flexing countless times to critical tolerances . . . on coldest winter nights or blazing summer days.

Duranickel might solve a design problem for you, too. Duranickel is an age-hardenable Nickel-Aluminum-Titanium alloy with the strength and *hardness* approaching that of heat treated alloy steel. Duranickel develops *tensile strengths* over 200,000 psi, and offers other premium properties unavailable in comparably priced *corrosion-resistant* alloys.

For full details on Duranickel or other INCO* Nickel Alloys write, today: *Riverside-Alloy Metal Division, H. K. Porter Company, Inc., Riverside, N.J.*

*TRADEMARK OF THE INTERNATIONAL NICKEL CO., INC.

RIVERSIDE-ALLOY PORTER METAL DIVISION

H. K. PORTER COMPANY, INC.

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ling can raise the hydrogen content of titanium by as much as 150 ppm. This amount added to the 150 ppm of hydrogen permitted by specifications would bring the total possible hydrogen content of titanium near the limit of embrittlement (300 ppm).

Vacuum fusion analysis of specimens taken from the fracture area of the part shown in the photo indicated that the specimens had a hydrogen content from 370 to 460 ppm. This excessive hydrogen was the result of heat treating in a furnace containing residual endothermic gases used for heat treating a prior load of steel.

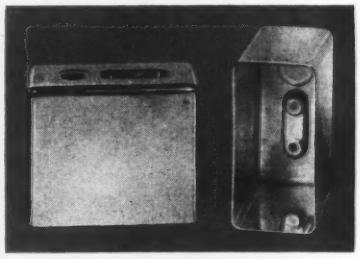
How titanium was tested

In the investigation, specimens of 6 Al-4v titanium sheet were prepared with hydrogen levels of 30, 200, 300, 400 and 500 ppm. Notched tensile specimens were heat treated 30 min at 1700 F, water quenched, and aged 4 hr at 1000 F. The heat treated specimens were then tested for 300 hr at room temperature under sustained loads of 65 to 85% of the material's 172,000-psi tensile strength.

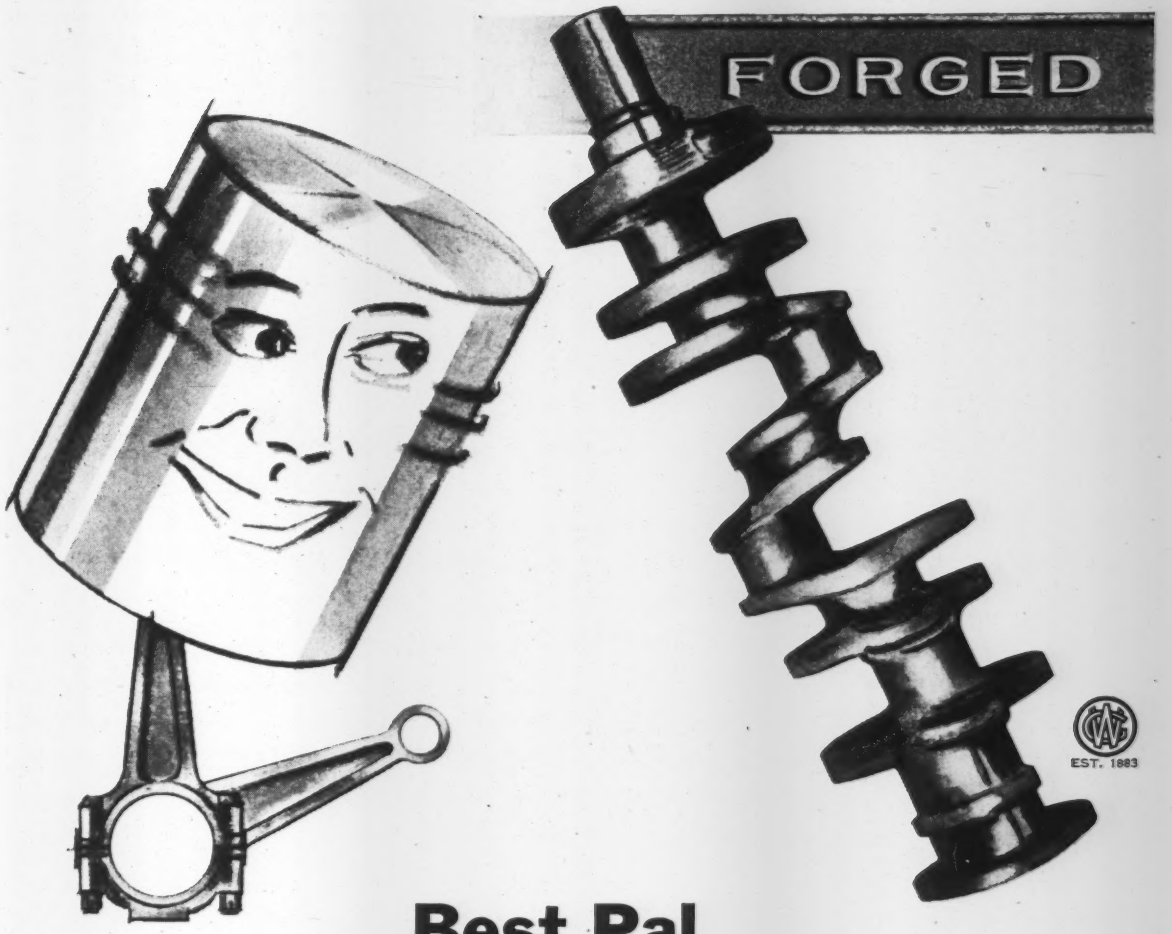
Tin-Plated Magnesium Is Easy to Solder

With the recent development of hot flowed tin electroplating on magnesium, soldering and hermetic sealing are more easily accomplished on lightweight magnesium electronic housings than on steel or copper.

This development by Brooks & Perkins, Inc., 1950 W. Fort St., Detroit 16 means that designers can use tin-plated magnesium for housing replaceable and interchangeable electronic parts in airborne radar



***Electronic housings** are made of tin-plated magnesium.*



Best Pal a Piston ever had

Crankshafts have been made successfully by other methods of fabrication and have proven good enough for certain non-critical applications—but for maximum dependability of the modern, compact, high-compression, high-torque, heavy-duty engine a forged crankshaft is essential.

In a crankshaft there is no substitute for a forging, and in a forging there is no substitute for Wyman-Gordon quality and experience.

WYMAN-GORDON

FORGING

Aluminum *Magnesium* *Steel* *Titanium* *Beryllium* *Molybdenum* *Columbium*

WORCESTER MASSACHUSETTS

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FORT WORTH TEXAS
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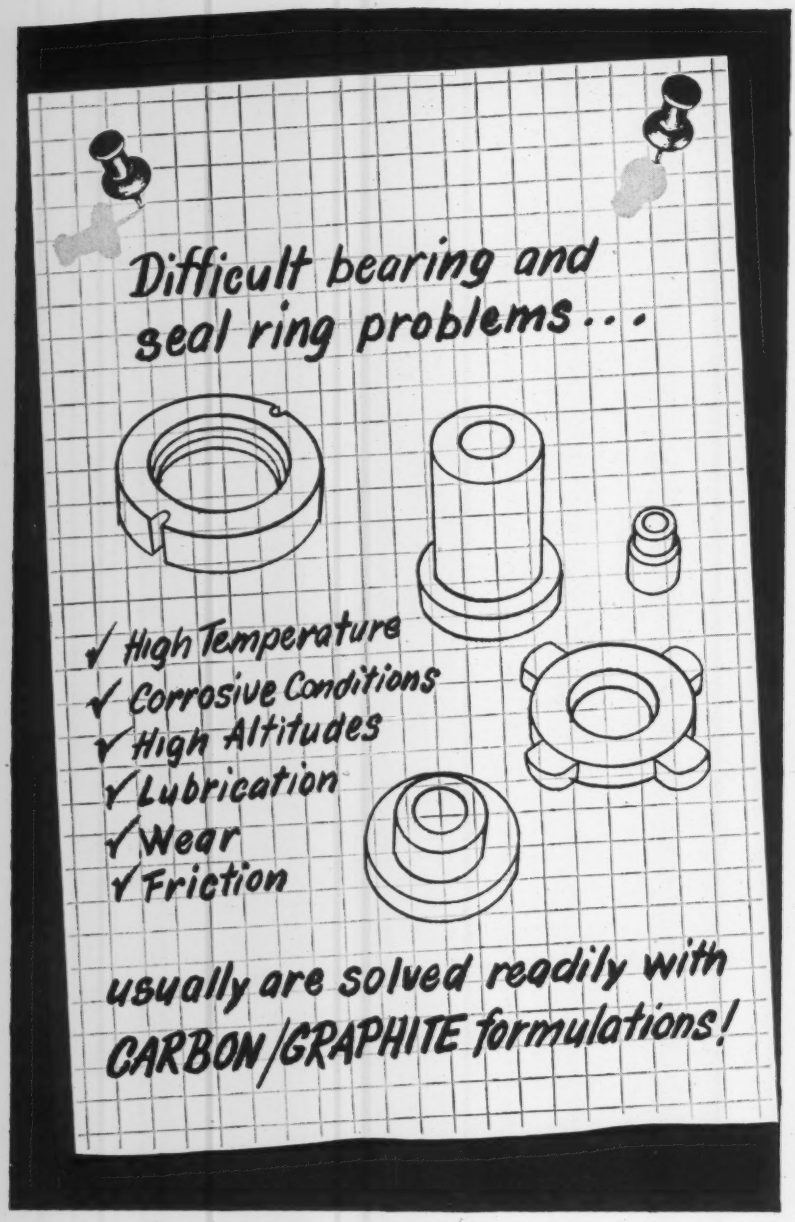


Many standard grades . . . countless specials . . . with physicals to match your performance requirements exactly. Outline your application for a prompt recommendation. STACKPOLE CARBON Co., St. Marys, Pa.

STACKPOLE

ROCKET NOZZLES • PUMP VANES • TURBINE RINGS • GRAPHITE CHEMICAL ANODES • VOLTAGE REGULATOR DISCS • BRUSHES FOR ALL ROTATING ELECTRICAL EQUIPMENT • WELDING & BRAZING TIPS • ELECTRICAL CONTACTS • CERAMIC MAGNETS • FERROMAGNETIC CORES • FIXED & VARIABLE COMPOSITION RESISTORS . . . and many other carbon, graphite and electronic products.

For more information, turn to Reader Service card, circle No. 448

What's new IN MATERIALS

systems, missile control systems and other electronic systems.

In making these parts, magnesium is fabricated into the desired shape, then copper and tin-plated. After tin plating the part is dipped in hot oil or fat at about 450 F. This dipping process fuses the tin and bridges over all microporosity in the copper plate. The tin electroplate is said to be strongly adherent and corrosion resistant.

Other News . . .

Metals

▸ An improved, wear resistant carbon tool steel for cold heading applications has been introduced by Latrobe Steel Co., Latrobe, Pa. The material, called Hedervan, is essentially a 0.90% carbon tool steel containing added carbon and vanadium in the form of vanadium carbides.

▸ A semiconductor alloy kit, designated Z-100 and priced at $100, is available for research and development projects from Accurate Specialties Co., Inc., 37-11 57th St., Woodside 77, N. Y. Included in the kit are aluminum-boron, tin-antimony, lead-silver, indium-germanium and indium-gallium semiconductor materials in the form of disks, spheres and washers.

▸ Research sponsored jointly by the National Bureau of Standards, U. S. Dept. of Commerce, Washington 25, D. C. and the Corrosion Research Council shows that stress-corrosion cracking of AZ31B magnesium alloy is primarily an electrochemical process and is dependent on strain rate. Details of the study are given in NBS Technical Report No. 2300.

Plastics

▸ An epoxy-fiberglass tubing for electrical uses is available from National Vulcanized Fibre Co., 1059 Beech St., Wilmington 99, Del. The tubing, designated Phenolite G-11-3680, can be used by itself or in combination with inner and outer layers of other materials. The epoxy-fiberglass laminate is said to have good electrical properties, high tensile strength (43,400 psi) and high bursting strength.

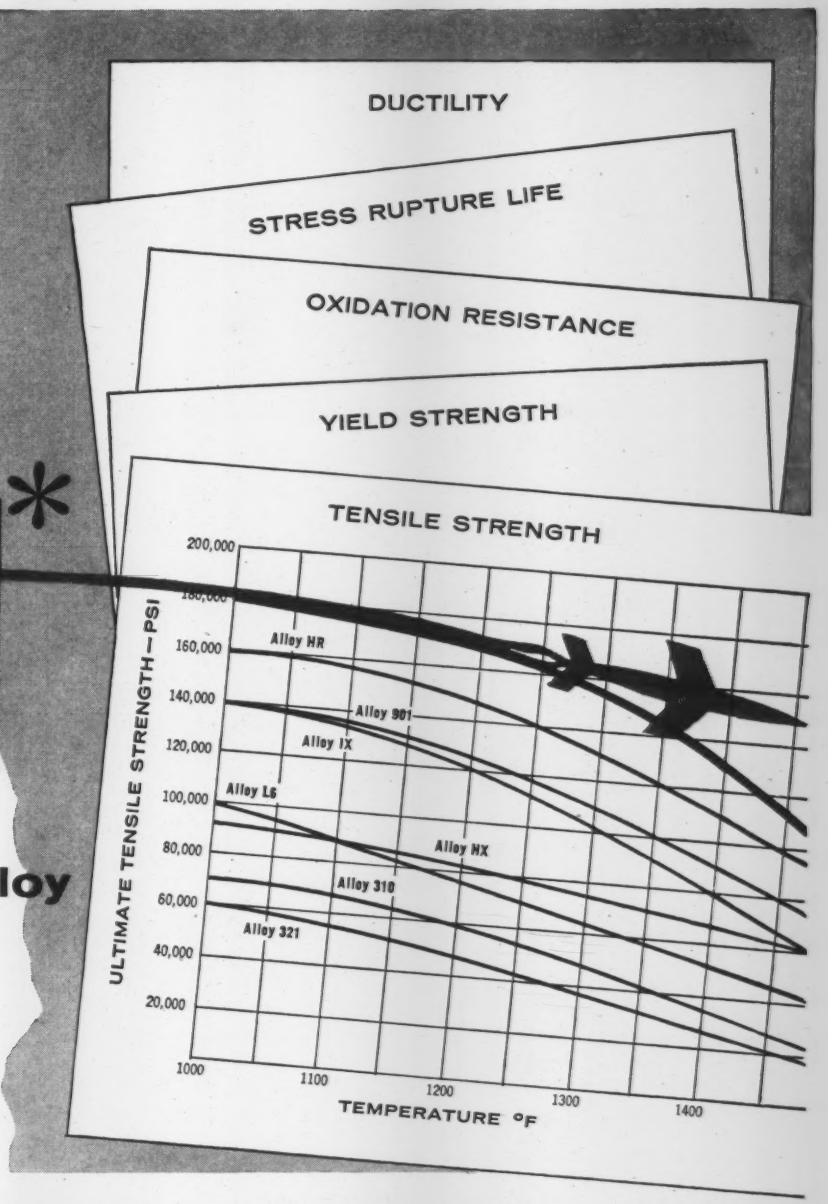
▸ Flexible, spaghetti, instrument and heavy-walled TFE tubing can now be printed with indelible numbers for identification purposes. The

HIGH

on every chart:

RENÉ 41*

most dependable alloy in use today in the 1200°-1800°F range



In *all* ways, René 41 is a remarkable alloy. No other high-temperature alloy used in production today equals its tensile strength. In other properties, too, René 41 is far ahead of the field.

Also important, this nickel-base, vacuum-melted alloy is easy to work with. It's readily formable by drawing, bending, spinning — welds to similar or dissimilar materials.

Cannon-Muskegon offers René 41 in standard 36″x 96″ sheets .015″ to .125″ thick, in smaller sizes down to .010″, in bar stock up to 3″ in diameter . . . foil down to .001 in thickness . . . and fine wire only .0015 in diameter.

For complete details, write for Technical bulletin No. 86.

*TM of General Electric Co.

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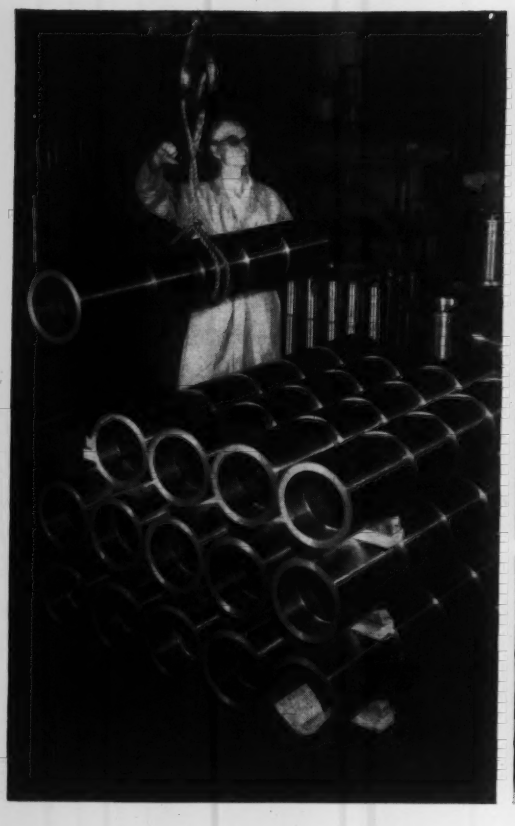
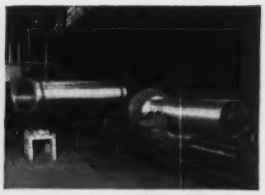
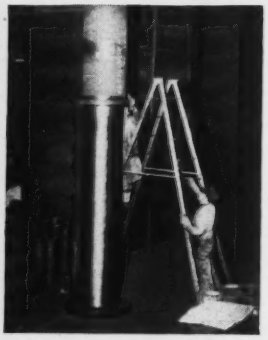
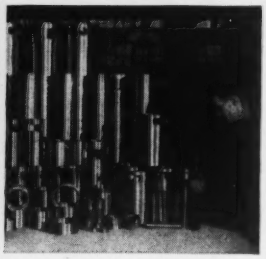

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Check with Shenango on centrifugally cast parts for your needs —large or small castings . . . rough, semi-finished or precision-machined . . . ferrous or non-ferrous. They'll cost you less in the long run. For bulletins, write to: *Centrifugally Cast Products Division,* The Shenango Furnace Company, Dover, Ohio.

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MONEL METAL • NI-RESIST • MEEHANITE® METAL • ALLOY IRONS

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What's new IN MATERIALS

producer says the numbers will not fade, chip or peel. The indelibly printed tubing is marketed by Pennsylvania Fluorocarbon Co., Inc., 1115 N. 38th St., Philadelphia 4.

▸ A white, stain resistant vinyl sheeting, called Colovin, has been introduced by Columbus Coated Fabrics Corp., 7th at Grant Aves., Columbus 16, Ohio. Tests show that the new sheeting is resistant to iodine, gentian violet, black and red hair dye, and ball-point pen ink.

▸ A light stabilizer for polyethylene resins is said to extend the life of sunlight-exposed polyethylene products two to five times, compared to unstabilized polyethylene products. The stabilizer, named AM 101, is also an effective light stabilizer for polypropylene resins. It is available from Ferro Corp., Chemical Div., Box 349, Bedford, Ohio.

Other nonmetallics

▸ Duramic HT-2-M is the name given to a machinable, thermal-shock-resistant ceramic now available in the form of rods, disks and custom shapes from Duramic Products, Inc., 262-72 Mott St., New York 12. According to the producer, the material can withstand temperatures up to 2200 F.

▸ A recrystallized synthetic mica sheet, still under development, shows promise as a possible substitute for natural mica in a number of applications. The material, developed by Synthetic Mica Co., Div. of Mycalex Corp. of America, Caldwell, N. J., has a dielectric strength of 900 to 1300 v per mil.

▸ Acheson Colloids Co., Div. of Acheson Industries, Inc., Port Huron, Mich. has introduced a new molybdenum disulfide additive for greases and heavy oils. The fine particle dispersion is said to provide substantially greater coverage than any fine particle molybdenum disulfide powder now commercially available. The dispersion is called "dag" 208.

▸ High purity tungsten carbide powder is a new product of Union Carbide Metals Co., Div. of Union Carbide Corp., New Products Engineering Div., P. O. Box 330, Niagara Falls, N. Y. The carbide powder is made by a new process, details of which have not been revealed.

▸ A new silicone grease designed as a rust inhibitor and lubricant for mated, threaded and non-threaded ferrous metal and rubber parts is

New High-Strength Material Extends Superior Line of Stainless Steel Tubing Analyses

PH 15-7 Mo, a new precipitation-hardening stainless steel analysis, possesses excellent mechanical properties at room temperature, outstanding ones at elevated temperatures. In addition, it is readily fabricated in the annealed condition, exhibits good corrosion resistance characteristics, can be hardened by heat treatment with minimum distortion.

Tubing of this new analysis is recommended for aircraft structural parts, studs and bushings, Bourdon springs and torque tubes in instrumentation, tubular springs, and hydraulic lines where severe bending and forming are required. It is available in WELDRAWN® form in size range from .012 through 1.125 in. OD.

In addition to PH 15-7 Mo, Superior offers the widest variety of analyses in the small-diameter tubing industry—over 120. This range permits you to specify the right one for your particular application. For complete information about PH 15-7 Mo and other analyses available for your needs, write Superior Tube Company, 2006 Germantown Ave., Norristown, Pa.

*Reg. U.S. Pat. Off., Armco-Steel Corp.

Superior Tube

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All analyses .010 in. to ⅜ in. OD—certain analyses in light walls up to 2½ in. OD

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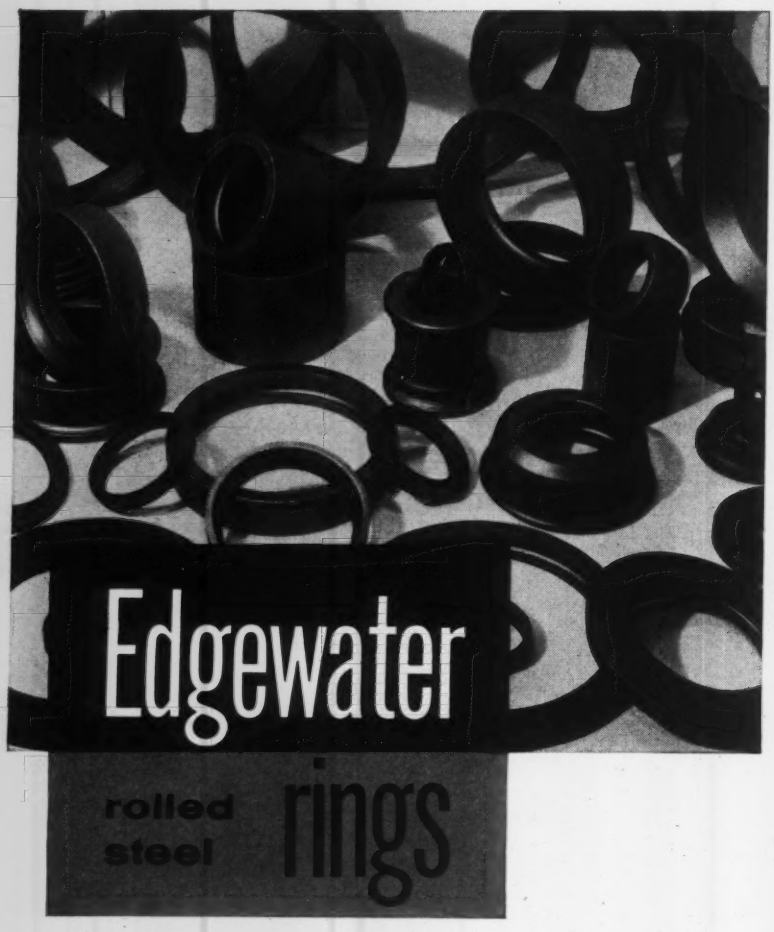


diameters 5 to 145 inches—accurate rolling reduces machining—simple or complex cross-sections—rolling gives strength, toughness

Rolled from solid blocks of steel, Edgewater Rings are strong and tough. Simple or complex cross-sections are formed to tolerances so close that only a minimum of machining is necessary. This means substantial savings in material and labor. Edgewater provides complete facilities for finishing and heat treatment, if required.

Write for descriptive illustrated bulletin.

Edgewater Steel Company

Dept. MDE • P.O. Box 478 • Pittsburgh 30, Pa.

For more information, turn to Reader Service card, circle No. 474

available from the Silicone Products Dept. of General Electric Co., Waterford, N. Y. The grease, designated SS-4007, is said to maintain its consistency at temperatures from –75 to 300 F.

Finishes

▸ Republic Hardfacing Corp., 479 Broadway, Bedford, Ohio, has developed a new hard facing technique for depositing a heat, shock and wear resistant cermet coating on valves, spindles, transmission shafts, blades and dies. The technique is said to fuse the cermet coating to the parent metal. The company has not revealed composition of the cermet.

▸ Horsey-Set is the name given to two new solvent-free protective coatings. One coating is an odorless tank lining that is said to have good resistance to steam, boiling water, gasoline, oil and grease. The other coating is a waterproof paint for decking. The two paints are marketed by Horsey-Robson & Co., Inc., 551 5th Ave., New York 17.

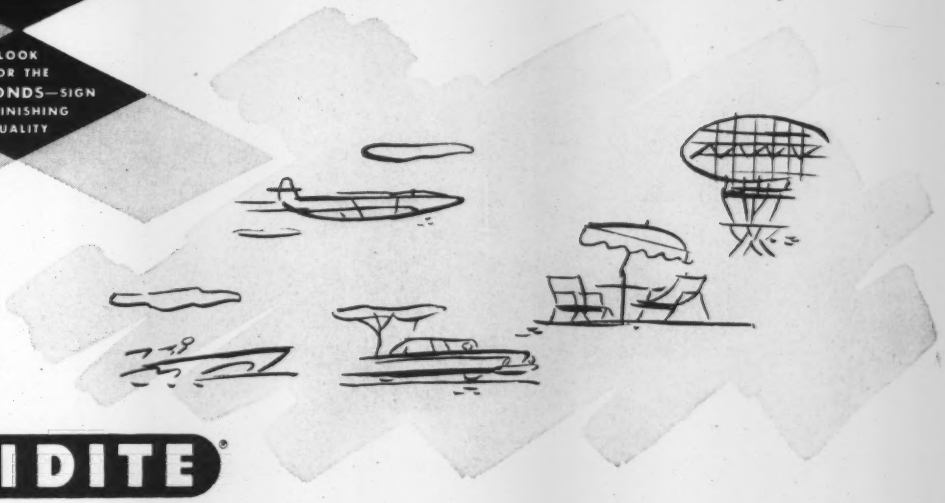
▸ A bright nickel plating solution is said to have high throwing power, a wide pH range (2.8 to 4.5), excellent leveling characteristics, and a wide temperature range. Electroplates produced by the solution are said to be free from the black deposits normally encountered in low density areas with other bright nickel plating solutions. The solution, called Hi-Thro, was developed by Seymour Mfg. Co., Electro Chemical Supplies Div., Franklin St., Seymour, Conn.

Joining materials

▸ A powdered metal bonding agent, is said to produce the strongest bond known between cemented carbide and steel. Joints with a rupture strength from 100,000 to 135,000 psi have been produced. The material, called Plymet, is available from Powder Alloys Corp., 316 Colfax Ave., Clifton, N. J. Its composition has not been revealed.

▸ A new welding process, called Short-Arc, has been developed by Linde Co., Div. of Union Carbide Corp., 30 E. 42nd St., New York 17. This new inert-gas, consumable-electrode process can be used manually to make fusion welds in all common ferrous and nonferrous metals ranging in thicknesses from 0.030 to 0.100 in.

LOOK FOR THE DIAMONDS—SIGN OF FINISHING QUALITY



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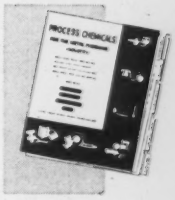
IRIDITE—a specialized line of chromate conversion coatings for non-ferrous metals. Apply by dip, brush or spray methods — at room temperature — manually or with automatic equipment. Forms a thin film which becomes an integral part of the metal. Cannot chip, flake or peel. No special equipment, exhaust systems or specially trained personnel required.



If you are using chromate conversion coatings to finish zinc, cadmium, aluminum, magnesium, silver, copper, brass or bronze — consider the above benefits of Iridite. For complete information, contact your Allied Field Engineer. He's listed under "Plating Supplies" in the yellow pages. Or, write for FREE TECHNICAL DATA FILE.

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"Inspect the product-improving, cost-cutting metal-like properties of new DELRIN®"

National can now furnish extrusions or fabricated parts of this remarkable new Du Pont thermoplastic

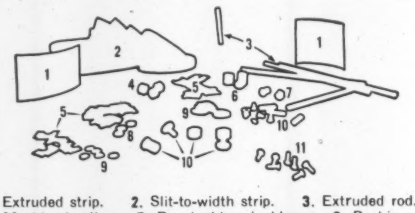
If you have not yet evaluated this exciting new material you will want to. Exhaustive tests show that "Delrin" can compete on a cost and performance basis with parts made of many metals, rubber, glass or wood. It may be the *one best material* to solve a current problem for you.

In adding "Delrin" to its family of thermoplastics, National continues the policy of offering the designer industry's widest selection of basic materials—over 100 types and grades. "Delrin" is available in extruded rod, strip, and special shapes, or in precision fabricated parts to your design. You can depend on National's production experience for sound help on "Delrin" applications.

Sizes now available include: rod—¼″ to 2″ diameter; strip—.020″ through .093″ thick, up to 7″ wide.

Special extruded shapes available upon request. Fabricated "Delrin" parts now being furnished National's customers indicate broad application wherever strength, rigidity and dimensional stability are important.

For specific information, prices and personal assistance on the use of "Delrin"—or any of the more than 100 National materials—write National Vulcanized Fibre Co., Dept. KK-10, Wilmington, Delaware. Or contact your nearby National Sales Office.



1. Extruded strip. 2. Slit-to-width strip. 3. Extruded rod. 4. Machined pulleys. 5. Punched terminal bases. 6. Bushings. 7. Terminal plugs. 8. Punched discs. 9. Punched washers. 10. Parts made in automatic screw machines. 11. Machined bolts.

For more information, turn to Reader Service card, circle No. 450

Vacuum bottle components *include glass vacuum filler (left); tip protector (shown supporting the filler); and outside casing.*

MATERIALS AT WORK

Adhesive—cont'd from p 12

would not do the job, Raybestos-Manhattan, Inc. was asked to develop a special formula. The new adhesive, designated R-84002 and based on an undisclosed thermoplastic resin, is designed specifically for materials that do not require high bonding strength. It is primarily a non-structural adhesive suitable for extended service at temperatures ranging from –20 to 160 F.

Method of application

The adhesive is applied by a specially developed machine (details undisclosed) which extrudes twin jets of the adhesive in a circular pattern. Little or no special surface preparation is required: the operator merely removes any foreign matter from the glass and polyethylene surfaces and heats both parts to moderately elevated temperatures. Adhesive is 1/16 to 1/32 in. thick.

According to Raybestos-Manhattan, the entire adhesive bonding operation is relatively simple as a result, paradoxically, of the difficult-to-bond materials involved. Polyethylene and glass have less tendency than other materials to attract and hold such bonding impediments as dirt, grease, etc., and, when properly designed, nest easily against each other.

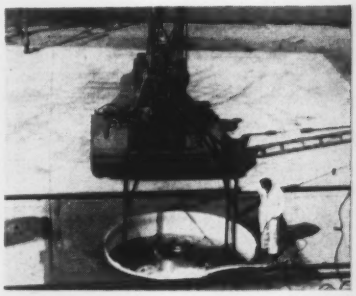
Jet Engine Parts Now Formed by Explosives

Explosive forming techniques are now being used by Ryan Aeronautical Co. to produce complex jet engine parts. According to Ryan, parts are produced faster, cheaper and with higher quality than is possible by conventional methods.

Shapes presently being formed by explosives include hemispheres, bell shapes, corrugations, deep draws, embossments, and many others. Materials presently being explosive formed include stainless steels, Inconel, titanium, brass, copper, aluminum, nickel and cobalt-base superalloys, and many others.

Most widely used explosives are: TNT (690,000 psi), nitroglycerine (1,200,000 psi), and 30% ammonia gel (490,000 psi).

In the process, a metal part is placed in a die and lowered into a water-filled pit. An explosive charge is positioned in the die and detonated, forcing the water against the part which is in turn forced into



Die and metal part *are lowered into water-filled pit.*

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Vulcanized Fibre: 10 standard grades; many special grades.

PHENOLITE® Laminated Plastic: over 80 standard and modified grades; paper, cotton fabric, nylon, asbestos, glass fabric, cotton and glass mat bases; phenolic, melamine, polyester, epoxy, teflon or silicone resins.

PEERLESS Electrical Insulation: coil, strip, corrugated.

Extruded Nylon, "Delrin", "Penton": rod, strip, tubing, special shapes.

Polyester Glass Mat: 4 standard sheet grades; custom molded shapes.

PHENOLITE Copper-Clad Laminates: 10 standard grades.

Combination Materials: Rubber-PHENOLITE; Rubber-Fibre; Wood-Fibre; Metal-Fibre; Asbestos-Fibre; PEERLESS-PHENOLITE.

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Water geyser *shoots high in air as explosive is detonated.*

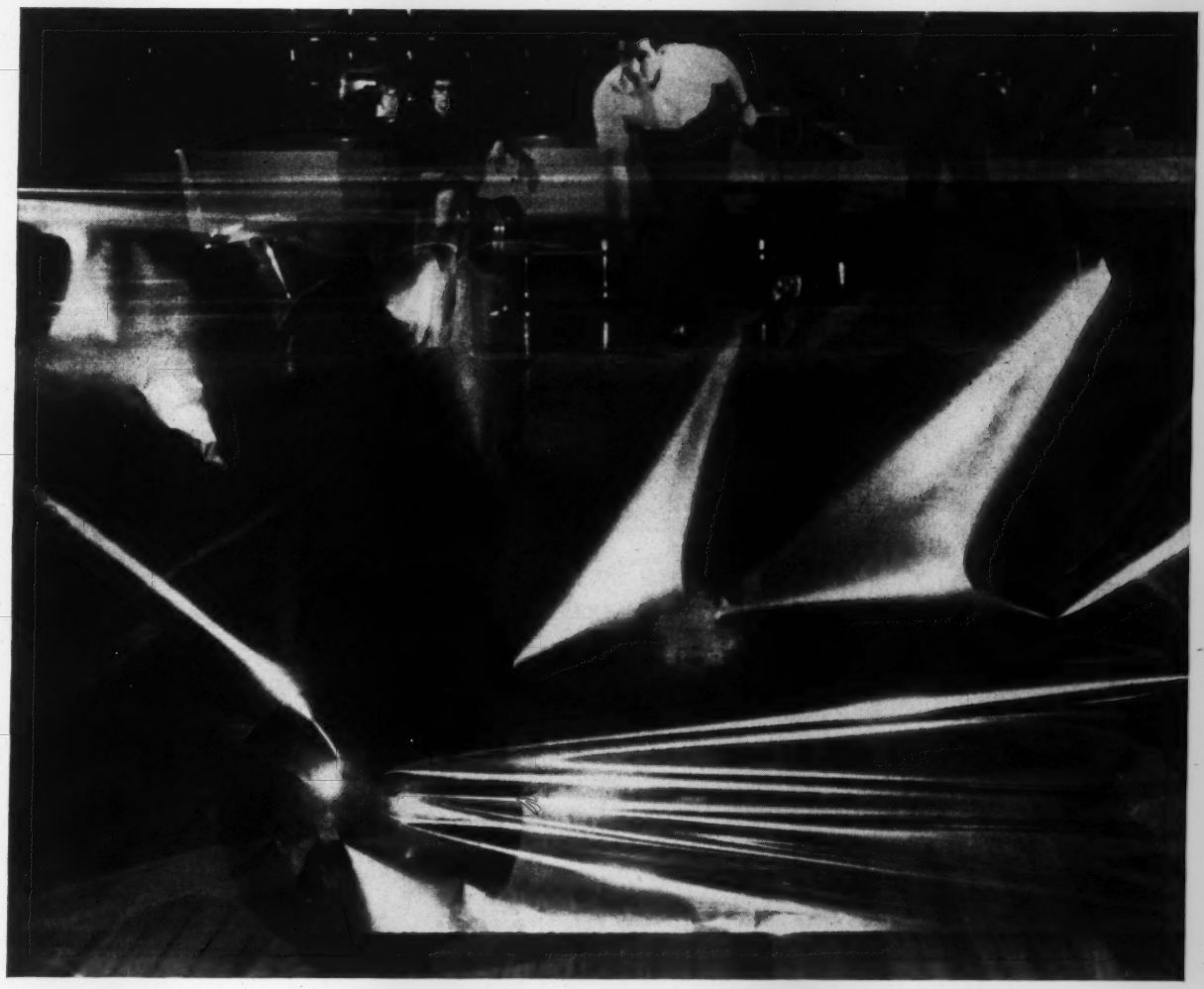
Jet engine part *is perfectly formed from metal blank at right.*

the shape of the die. The water then blows out the top like a geyser. The metal is moved into shape at speeds up to 200-500 fps, as compared to only 1-5 fps for ordinary methods. (For a comprehensive discussion of explosive forming, see M/DE, Feb '59, p 82.)

In addition to speed of forming, other major advantages include: 1) elimination of work hardening and springback; 2) use of inexpensive dies (they can be made of lead-zinc alloys or plastics); and 3) replacement of massive, expensive machines with an outdoor waterpit and a few cents worth of explosives.

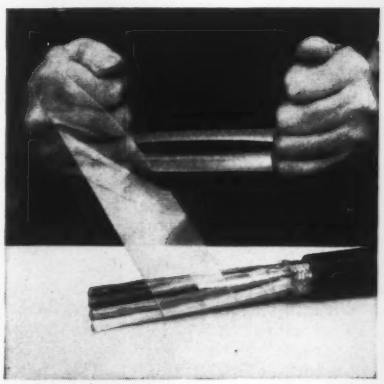
Dacron-Mylar Sphere to Invade Outer Space

The huge Dacron-reinforced Mylar sphere shown in the accompanying photo will soon be shot into outer space to determine the exact density



MYLAR® has a tensile strength of 20,000 psi

Can the unique combination of properties found in "Mylar" help you solve your design problems?



Tough, thin "Mylar" helps cut cable costs! Because "Mylar" is tough even in thin gauges, cable manufacturers can cut size, weight and manufacturing costs.

"Mylar"* polyester film is a tough, flexible engineering material. In addition to its average tensile strength of 20,000 psi, "Mylar" has excellent resistance to most chemicals and moisture, a dielectric strength of 4,000 volts per mil for 1 mil film, and can withstand temperature extremes from -60° to 150°C.

On an area basis, tough, thin "Mylar" often *costs less* than heavier, conventional materials. "Mylar" can be laminated, embossed and metalized, punched or coated. The film won't become embrittled with age. "Mylar" is available in roll or sheet form in a wide range of gauges.

Find out how the *combination of properties* in "Mylar" can help you solve knotty design problems, improve product performance or cut costs. Write today for our new booklet containing detailed information on properties and applications. E. I. du Pont de Nemours & Co. (Inc.), Film Dept., Room MM-10 Wilmington 98, Delaware.

*"*Mylar*" is Du Pont's registered trademark for its brand of polyester film.*

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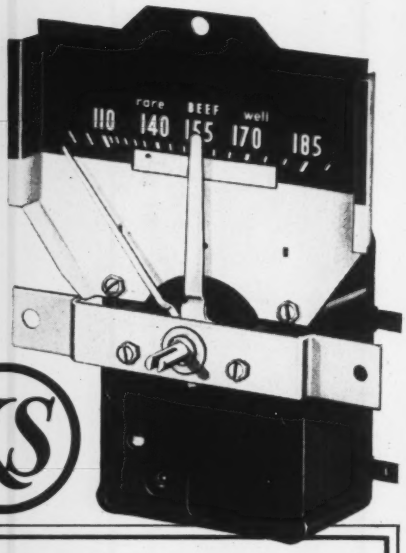
Chace Thermostatic Bimetal

ACTUATES ANOTHER PRECISION PRODUCT...



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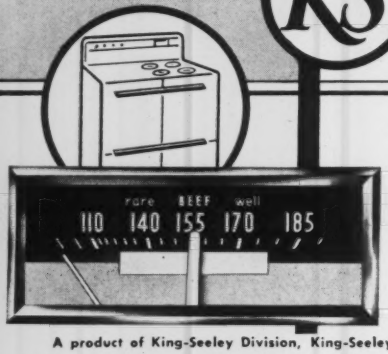


THE KING-SEELEY ROAST CONTROL

A product of King-Seeley Division, King-Seeley Corporation, Ann Arbor, Michigan

The King-Seeley Roast Control was introduced on 1959 Westinghouse ranges as their "Serv-Temp Roast Guard" with the slogan "Never again a ruined roast." It controls inside meat temperatures so that when the roast is done — rare, medium or well done — as you like it, the oven heat is brought down to inside meat temperature holding the roast, juicy, flavorful, oven hot, for hours if necessary regardless of how long a dinner may have to be delayed. Three elements of Chace Thermostatic Bimetal are used. The indicator bimetal accurately shows inside meat temperature and starts the control function anticipating the desired degree of doneness. The responder bimetal uses this information to control the oven thermostat. The voltage regulator bimetal provides a constant voltage supply to the system.

Triple responsibility is evident here — and all dependent on those three small bits of Chace Thermostatic Bimetal. The manufacturers of appliances to whom King-Seeley sells have a vast responsibility to millions of customers all over the world. They must not permit their products to misfunction or malfunction, regardless of abuse or lack of attention. King-Seeley has a fine old reputation to maintain as a major supplier of dependable controls and indicators. Chace produces the critical bits of metal on which the two may safely base their claims as leaders in their fields. It's natural that such buyers go where history indicates they'll get the finest precision bimetal available — where a third of a century of production and development experience back up every fraction of an ounce.

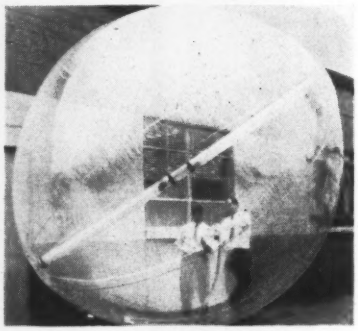
While your new temperature actuated device is in the preliminary design stage, send for our booklet, "Successful Applications of Chace Thermostatic Bimetal." It's full of design engineering data with illustrated examples of uses of bimetal. Remember, too, that our precision product is available in strips, coils or completely fabricated elements of your design.

IT BENDS WITH THE HEAT

W. M. CHACE CO.
Thermostatic Bimetal
1615 BEARD AVE., DETROIT 9, MICH.

For more information, turn to Reader Service card, circle No. 472

MATERIALS AT WORK

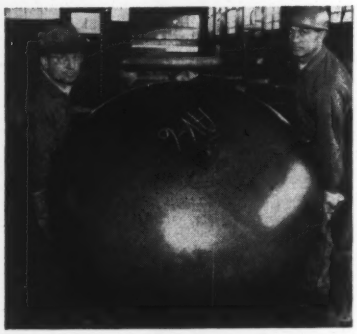


Density of atmosphere *in outer space will be determined by flight of balloon.*

of the atmosphere 300 miles above the earth.

According to Arthur D. Little, Inc., the sphere will be ejected from a two-stage rocket at a height of 60 miles. It will then follow the trajectory of the projectile up to the zenith of 300 miles. During the free flight, which will take about 7 or 8 min, instruments will note and relay the amount of drag induced by the rarefied gases in the upper atmosphere.

A major problem faced by the



Largest titanium head—What is claimed by Lukens Steel Co. to be the largest titanium head shape ever produced was recently formed of B 120 VCA—Crucible Steel Corp.'s new beta alloy (see M/DE, Sept '58, p 131). The head, which is 54 in. in dia and 0.085 in. thick, weighs 50 lb. To achieve this large size, two titanium sheets were welded together before forming. The head will be used by Wright Aeronautical Div., Curtiss-Wright Corp., in its missile development program.

PROGRESS IN PLASTICS

THE TROUBLE WITH PRINTED CIRCUITS— AND HOW CDF WORKS TO SOLVE IT

The honeymoon is long since over; suppliers and manufacturers are engaged now in the humdrum activity of making printed circuits *work*. The industry found in time that there was still a long way to go before the *magic* of printed circuitry was proved incontrovertibly in practice. The truth: Too many mass-produced printed circuits simply were no good. Why?

The trouble was not in the theory. Or in approved manufacturing techniques. It lay—and still lies—in raw materials, primarily in the consistency of quality of base laminates.

We're not here to say that CDF has a totally rosy record in this field. No, we've had our share of failures along with our many triumphs. In fact, our failures during the early years of copper-clad laminates taught us certain important things that our competitors have yet to learn.

But we do emphasize this: We've made—and are still making—great progress at CDF in licking problems that have beset the printed-circuit producer and the printed-circuit user in obtaining top-quality laminates on every order, regardless of grade.

Here, for example, are a few areas where CDF R&D has been particularly active:

1. Consistent quality. A major cause for printed-circuit rejects has been delamination and blistering of the base laminates when subjected to high temperatures in processing. New developments in CDF raw-materials control promise a heartening break-through in this respect. Also, CDF technical personnel are engaged in counseling circuit manufacturers in optimum handling and processing techniques.

2. Foil-bond strength. Certain metal-clad laminates seem to pass the most rigid laboratory tests, only to fail at the end of manufacture when dipped in solder or when put through long-term operational tests at elevated temperatures. The foil-bonding strength of CDF Di-Clad® laminates, however, is recognized throughout the industry as superior in every grade.

Nevertheless, improvements are being made daily in foil adhesives and bonding methods at CDF, and bond strengths are being increased—not only in number of pounds required for foil separation, but in length of safe solder-immersion and high-temperature operation time.

3. Range of selection. CDF has consistently offered the widest range of metal-clad grades—in phenolic and epoxy paper-base, epoxy-glass, and Teflon*-glass. And CDF Di-Clad Teflon-glass grades remain the only laminates of their kind approved by the military. CDF Technical Bulletin 11,900 gives the latest information on all Di-Clad printed-circuit grades.

* du Pont's TFE fluorocarbon resin

4. Flexible grades. Newly-perfected *flexible* grades of CDF Di-Clad promise the designer even greater freedom. One of the headaches in the use of printed circuits has been their rigidity. They tend to hamper independent movement and vibration of connected systems. They occasionally dictate inconvenient housing shapes. Flexible printed circuits, however, overcome these objections and provide many additional benefits of their own. Details on how CDF flexible Di-Clad materials can help see you out of a printed-circuit problem can be obtained from your CDF sales engineer. Look up his phone number in the Product Design File (Sweet's), Electronics Buyers' Guide, or your own CDF catalog. Or send us your print or your problem, and we'll return recommendations based on your individual needs.

NEW CDF LITERATURE

Information on new grades, special applications, and outstanding properties of CDF insulating materials is made available regularly through CDF Technical Bulletins and Folders. The following literature is new. For copies of any bulletins listed, send the coupon below.

CDF Di-Clad Laminates—
Bulletin 11,900

CDF Skived Tapes of Teflon—
Bulletin 97

CDF Pressure-Sensitive Tapes of Teflon
Bulletin 102

CDF Grades Meeting NEMA, ASTM, Federal, and Military Specifications—
Bulletin 10,100

CDF Dilecto® Paper-Base Laminates—
Bulletin 11,110

CDF Dilecto Epoxy Laminates—
Bulletin 11,200

CDF Spiral Tubing—
Bulletin 14,000

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NEWARK 16, DELAWARE

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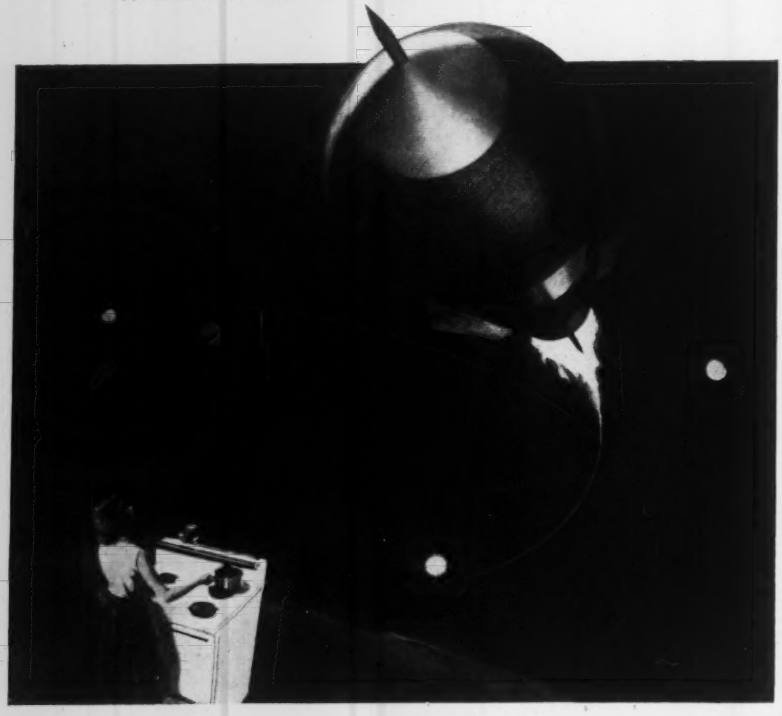
A SUBSIDIARY OF THE Budd COMPANY • NEWARK 25, DEL.
In Canada: 46 Hollinger Road, Toronto 16, Ontario

For more information, turn to Reader Service card, circle No. 525

From the Kitchen to the Stars

Already used as insulation inside the heating elements of electric appliances, magnesium oxide is destined for an important part in the drama of advanced materials technology. Its unique properties suggest possibilities in the coming conquest of space and in many specialized applications. For further details, see below.



A unique refractory material from electrical fusion

Electrically fused magnesium oxide is a white, crystalline refractory material of exceptional purity and inertness. Its melting temperature is over 4,700 F. It has a very high density that combats shrinkage problems and its electrical resistivity at elevated temperatures is unusual.

HIGH PURITY APPLICATIONS: As a refractory, bonded fused magnesia (over 98% MgO) holds great promise for use in crucibles in melting work where contamination must be kept low. Nickel, cobalt and their alloys—and even uranium—can be melted in such crucibles for high purity work.

PRECISE CONTROL OVER GRAIN GEOMETRY, which permits controlled high-pack densities, leads to application in rammed linings for induction and arc furnaces and to investment molds, thermocouple swaging tubes and insulation for electrical use.

THE PROMISE OF DUCTILITY: Interest has been heightened by recent rocket and missile developments and by indications that MgO crystals may in time make possible man's first ceramic material with the quality of ductility. To learn more about this interesting material . . .

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For more information, turn to Reader Service card, circle No. 403

designers of the 9-ft sphere was: what materials to use in its construction. Several materials were considered: plain polyester (Mylar) film, a neoprene bladder in a nylon shroud, polyethylene, and Dacron-reinforced polyester film. Polyester film was ruled out because the thickness necessary to provide proper strength made handling difficult. The neoprene-nylon combination was rejected because the neoprene bladder tore when subjected to extreme stresses. Polyethylene was rejected because it tended to stretch and lose its shape.

Dacron-reinforced Mylar was finally specified because it possessed sufficient strength and rigidity to 1) maintain its shape; 2) provide a stable platform for the accelerometer; and 3) withstand both the tight packing and the shock of almost instantaneous inflation from a compact package 8 in. in dia and 2-3 ft long.

A second problem faced by the designers of the sphere was how to inflate it. The solution involved the ingenious use of alcohol, a child's balloon, some thumb tacks and a perforated polyethylene bag. At a predetermined time, a signal will eject the 18-lb package through a door in the rocket's shell. The ethyl alcohol in the small balloon begins to evaporate and the resulting gas expands the balloon against the thumb tacks. When the balloon bursts, the expansion continues through the perforated polyethylene bag until the entire sphere is inflated. Total time from ejection to complete inflation is about 2 min.

Phenolic Laminate Reduces Shuttle Cost

One way to reduce the cost of a part is to specify a more expensive material—providing the new material lasts substantially longer than the one it replaces. This is exactly what happened when laminated plastics replaced dogwood for shuttles used on high speed weaving looms.

According to Formica Co. and Draper Corp., joint developers of the specially compounded phenolic-impregnated cotton laminate, total cost

Exacting Requirements?

for PRECISION... specify

ACIPCO

CENTRIFUGALLY SPUN STEEL TUBES

For almost 80 years, Morton Manufacturing Company of Muskegon Heights, Michigan, has been progressively building bigger and better machine tools.

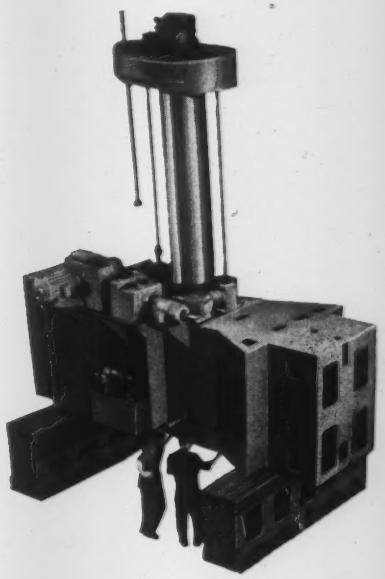
This ultra-modern turning and boring mill is 27 feet x 22 feet x 40 feet high, and weighs 525,000 pounds. Load capacity is 120,000 pounds. Driven with 210 horse-power, it is the first machine of its type wherein the work remains stationary.

Because of the herculean task this machine must perform, each component must be capable of precise performance under extreme loads. Morton wisely selected ACIPCO centrifugally spun steel tubing for the gigantic quill which houses and guides the rotary spindle. This tube is 24″ in diameter, 3″ in wall thickness and 17′6″ long.

ACIPCO centrifugally spun tubes have a dense, non-directional grain structure that has extra-ordinary strength and durability, and is more easily machined to close tolerances.

Whatever you may have in tubular applications, call on ACIPCO for perfect dependability. Our technical and manufacturing competence will serve your exacting needs.

MORTON



Morton Manufacturing Company, of Muskegon Heights, Michigan, is a leading manufacturer of heavy duty machinery for the machine tool industry. Boring mills; drillers, planers, as well as special machine tools for national defense and the development of new processes are among their products.

ACIPCO Centrifugally Spun TUBES

SIZE RANGE: Lengths up to 410″ have been produced to meet modern machinery requirements. OD'S from 2.25″ to 50″; wall thicknesses from .25″ to 4″.

ANALYSES: All alloy grades in steel and cast iron, including heat and corrosion resistant stainless steel, plain carbon steel and special analyses.

FINISHED: As cast, rough machined, or finished machined, including honing. Complete welding and machine shop facilities for fabrication.

SPECIAL PRODUCTS DIVISION

AMERICAN CAST IRON PIPE CO.

BIRMINGHAM 2, ALABAMA

ACIPCO

For more information, turn to Reader Service card, circle No. 436

How much does each .001" of Stainless Steel Sheet cost?

Example: In Type 302, an 18 gauge 36" x 120" sheet has a base price of 52¢ per pound. In sheets of this size, each .001" of thickness weighs 1.26 pounds per sheet. Thus, each .001" of unnecessary thickness costs you at least 65.5¢ more per sheet.

On the surface this may seem insignificant, but it has a marked effect on the total price you pay for a given quantity of stainless steel sheet. With cost a factor, this can be important since stainless steel is purchased by weight.

Using the above example, a mere .001" of unnecessary thickness costs you $20.76 more per ton. If you figure the maximum allowable gauge thickness variation of plus or minus (10%), you can readily see that the price you pay for overall sheet thickness could involve much needless cost.

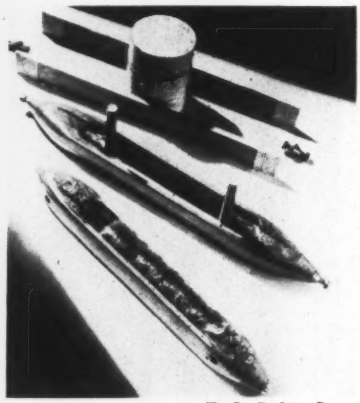
Washington Steel has the equipment and the experience to produce MICROROLD stainless steel to tolerances much closer than standard industry tolerances. Usually money can be saved by first selecting the minimum gauge that will serve the requirements of the application, and then specifying that the thickness be rolled to the light side of the gauge range. This specification involves no cost extra and is standard practice at Washington Steel. (If exact close tolerances must be guaranteed, there is a nominal additional charge.)

Consult your nearest MicroRold Stainless Steel Distributor. He will gladly show you how to save money on your stainless steel purchases.

Washington Steel Corporation
10-F Woodland & Griffith Avenues
Washington, Pa.

WASHINGTON STEEL CORPORATION · MicroRold · STAINLESS SHEET & STRIP

For more information, turn to Reader Service card, circle No. 538



F. J. Stokes Corp.

Improved shuttle *consists of side members made of multiple strips of phenolic laminate, and integrally molded steel tips.*

of the molded plastics shuttle is roughly three times more than that of the wood shuttle—but it lasts about six times longer.

The new shuttles are said to last longer because: 1) the phenolic-impregnated cotton laminate is inherently stronger and more shock resistant than dogwood, and 2) the design has been improved. The new shuttle consists of multiple strips of unidirectional resin-saturated cotton premolded into a frame with a slot down the center for the bobbin (see accompanying photo).

The pointed ends of the shuttle are made of resin-saturated macerated cotton duck molded around steel tips. The steel tips provide greater resistance to the heavy arms which propel the shuttle back and forth during weaving. After molding, the steel tips are machined to a point.

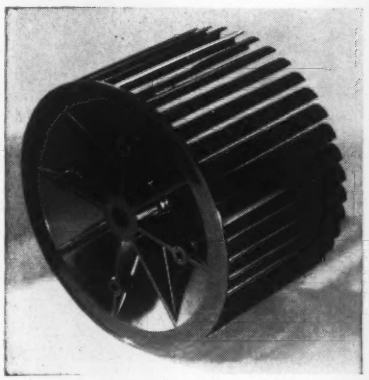
Cast Stainless Blade Simplifies Wire Peeling

A stainless steel casting is the key to the efficient operation of a new peeling device which is said to provide easier, safer and cheaper peeling of insulation from heavy electrical cables.

The new peeler, which uses type 431 stainless steel blades, is hooked over the wire or conductor, tight-

PRODUCT-DESIGN BRIEFS FROM DUREZ

- **a phenolic that simplifies**
- **plastic that foils vandals**
- **resins that bind**



DENBO ENGINEERING & SALES CO., INC.

Breezy brainwork

Q. What's missing from this blower wheel?

A. The ring that you'd expect to see steadying the blades at the far end.

Who forgot it? Nobody. In this wheel it's superfluous. Without the ring, air enters the wheel more freely. There's more working blade area. Air flow can be modified at the factory, without retooling, simply by shortening the blades.

You can't make a wheel like this out of metal—not at a marketable price, anyway. But a general-purpose Durez phenolic works fine.

Concentricity is molded in. Wobble is much less than could be achieved economically in a metal wheel. The wafer-edged blades are rigid enough to do without tip support. They can't be bent in shipment or in assembling the blower into any appliance of which it is a part. The wheel withstands moisture and mild corrosive atmospheres; retains its shape through the range of temperatures at which it will operate.

You don't make blower wheels? All right. We're happy if we have implanted an idea for *anything* you might construct better or more cheaply with a Durez general-purpose phenolic. For still more ideas on where and how to apply these durable, versatile materials, send in the coupon requesting Bulletin D400.

Vandalproof

Big-city switchblade artists used to rip the stuffings out of upholstered bus seats—to the tune of $100,000 a year in damage.

Then city transit authorities ordered 330 new buses with glass-reinforced plastic seats like the ones you see here. Made with tough, fire-retardant Hetron® polyester, these seats can't be slashed, defy destruction.

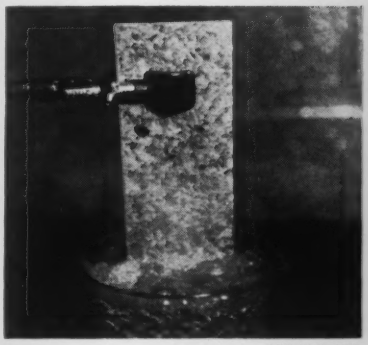
They cost less to make than upholstered seats. And the passengers like them better—voted overwhelmingly in favor of them in rider reaction tests.

Now transit officials plan to replace *all* the city's buses with vehicles featuring these vandalproof seats.

AMERICAN SEATING COMPANY

Where can *you* see a market for strong reinforced-plastic shapes that retard fire? There's a whole family of Hetron resins to help you do your visualizing. Hetron is *inherently* self-extinguishing—gives fire retardance with no loss of mechanical strength. Heat resistance, moisture resistance, electrical properties of Hetron laminates and premix-molded shapes are outstanding.

To get a better idea of what you can do with these fire-retardant resins, use the coupon to request the complete Hetron data file.



KENTILE, INC.

A pinch of permanence

No, cooking does not improve the flavor of this cork tile.

We're just demonstrating the good strong bond that's possible, in a material such as cork, with Durez phenolic resins. Not even boiling water can weaken it.

Locking cork granules together is one of hundreds of bonding jobs these resins can do. You might want to delve into their equally salutory effects on rubber, paper, sand, asbestos, or ground wood.

Under heat, the resin softens, then sets hard, presenting thereafter a permanently stubborn front to heat, moisture, and abrasion. You can get resins that impart many different combinations of useful properties. It doesn't take much resin—often only one part in ten—to get the results you're looking for. And phenolic is one of the lowest-priced bonding agents you can buy.

If you want to know how you might add a pinch of permanence to a product, mail us the coupon. The bulletin you'll receive tells how 12 industries are doing this very thing with Durez resins.

For more information on the Durez materials mentioned above, check here:

- ☐ 8-page Bulletin D400 lists properties, uses, design advantages of general-purpose Durez phenolics and other thermosetting materials.
- ☐ Data file (50A) on Hetron fire-retardant polyester resins.
- ☐ Industrial applications of Durez phenolic resins (12-page bulletin).

Clip and mail to us with your name, title, company address. *(When requesting samples, please use business letterhead.)*

DUREZ PLASTICS DIVISION

1410 WALCK ROAD, NORTH TONAWANDA, N. Y.

HOOKER CHEMICAL CORPORATION

HOOKER CHEMICALS PLASTICS

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GUARANTEED LAMINATED PLASTIC PARTS

Sheets, Tubes, Rods, Dies, and Tools

2 Fabricating Plants...

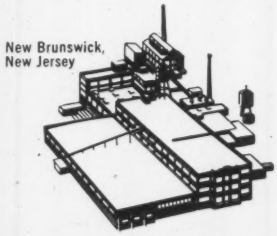
ALL BY RICHARDSON

For many years The Richardson Company has served industry as a skilled fabricator of high quality, uniform laminated plastic parts . . . produced to exacting customer specifications.

As the manufacturer of INSUROK® laminated sheets, tubes and rods, Richardson guarantees the finest fabricating materials in a wide range of NEMA, Federal and Special Grades.

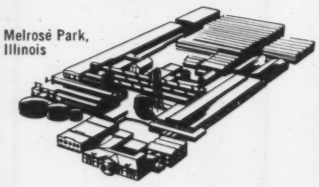
Fabrication dies and tools are designed and produced right in Richardson plants. Therefore, they are properly engineered for the material and will produce quality parts.

Two Richardson plants located in New Brunswick, New Jersey and Melrose Park, Illinois offer complete fabrication facilities for all forms of laminated plastics. This assures you prompt shipment of finished parts.



From ONE RELIABLE SOURCE you obtain quality materials, tooling, and fabricated parts.

To get more details on how Richardson's integrated fabrication facilities can serve you, write to The Richardson Company.



the RICHARDSON COMPANY

LAMINATED AND MOLDED PLASTICS Founded 1858

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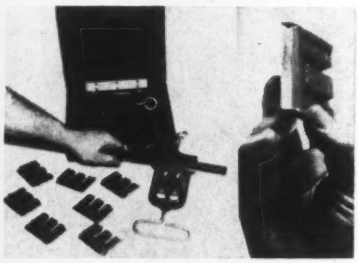


Peeling device *(left) uses 431 stainless steel blades (right).*

ened by hand or with a hot stick (a 6 to 10-ft long pole used by power companies for numerous jobs), and then rotated around the conductor until the insulation falls away. Nicking the wire is impossible because the cutting blade is positioned accurately by a built-in stop. Several blades are available for different size wires.

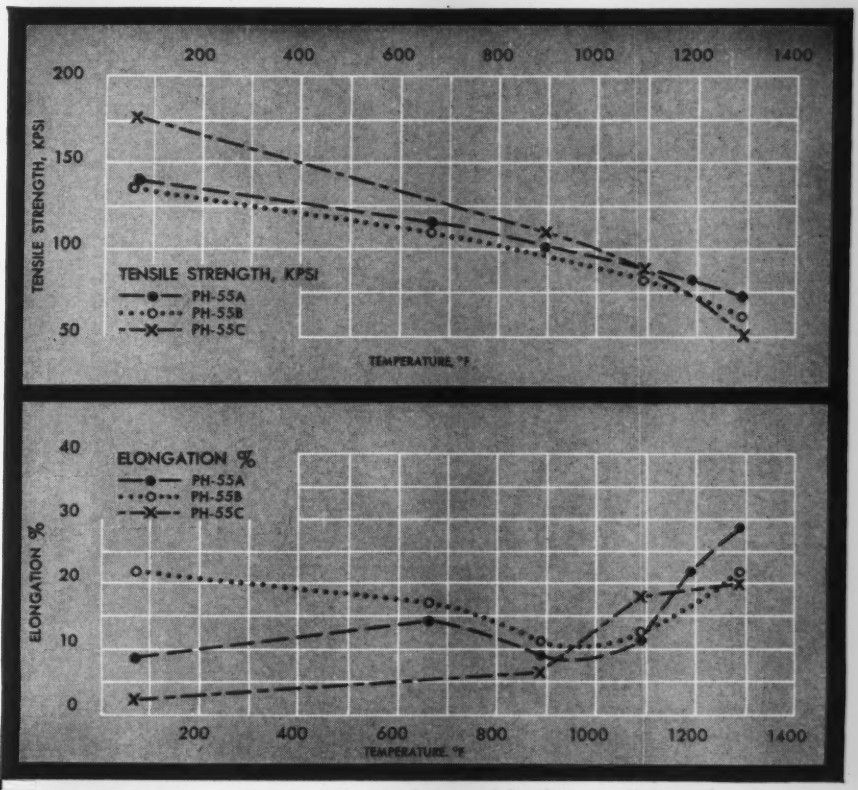
According to Allegheny Ludlum Steel Corp., the new peeler can accomplish in a few minutes what previously required up to 4 hr—and service is not interrupted.

Polyethylene Chutes Best for Concrete

High density polyethylene is replacing steel for chutes used to handle concrete, coal, grain and other industrial products.

The new chutes, made by Abutco Plastics Industries, Inc., are said to be about 25% lighter, 30% lower in cost and considerably longer lasting than the previously used steel chutes. According to Celanese Corp. of

Polyethylene chutes *last longer, cost less than steel.*



Precipitation-hardenable stainless steel alloys by Cooper Alloy that combine corrosion resistance, high hardness, machinability and strength even at high temperatures.

Balanced physical properties—Alloy "A" has good hardness and strength, even at elevated temperatures, plus a moderate amount of ductility and toughness. "B," though less hard, exhibits improved ductility and toughness at practically the same strength level. "C" provides optimum combination of hardness and strength at room temperatures.

New stainless steel alloys by Cooper Alloy

Where Can You Use Them? Cooper Alloy Corp., whose name for the past 36 years has been associated with outstanding developments in casting of stainless steel, now brings American industry another unusual "first": a series of 18-8 stainless alloys which combine corrosion resistance, high hardness, high strength and machinability. The new alloys maintain these properties even at temperatures up to 1400°F., resisting pitting corrosion and the detrimental erosion effects of velocity and suspended abrasives which accentuate corrosion damage.

The alloys in this new series are:

PH-55A: A high-strength, high-hardness alloy designed for corrosion-erosion and corrosion-abrasion conditions. Outstanding pitting resistance.

PH-55B: A high-strength alloy of greater ductility and lower hardness than "A," for corrosion resistance of parts subjected to a combination of stress and shock.

PH-55C: With greater corrosion resistance, hardness, and strength than "A," but less ductility and shock resistance.

All PH-55 Alloys have higher strengths in the 1200-1400°F. range than do most other corrosion-resistant precipitation-hardening alloys, and they maintain their hardness even after prolonged exposure to these high temperatures. Alloy "A" is highly resistant to pitting corrosion; both "A" and "C" to high-velocity erosion-corrosion such as is common in pumps handling corrosive abrasives. All three are in general superior to 316 alloys in all corrosive applications except hot conc. HNO_3. Patents have been applied for or granted on the PH series of alloys.

Alloys "A," "B," and "C" are all easily machined when in the annealed condition. Welding is routine, and heat treatment easy and relatively uncritical.

Where can YOU use these alloys? They should be very useful anywhere that velocity, abrasion, wear, and high temperature are present under highly corrosive conditions.

For further information, write to Cooper Alloy Corp., Hillside, N.J.

COOPER ALLOY

For more information, turn to Reader Service card, circle No. 493

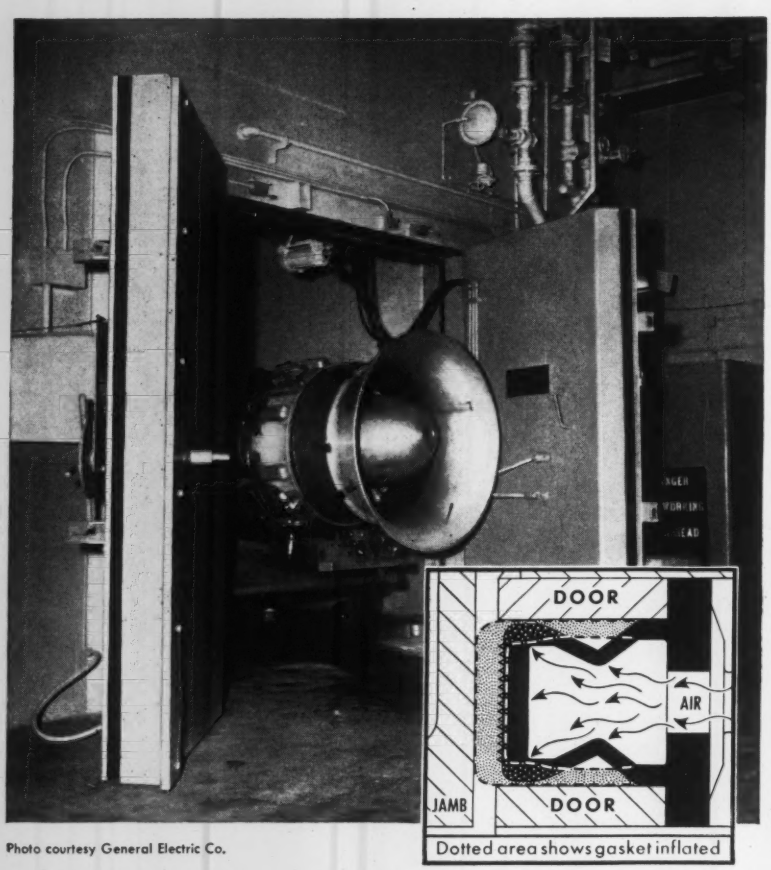


Photo courtesy General Electric Co.

Pneumatic Rubber *Door Seal* Muffles Test Cell Noises

To more effectively suppress noise, General Electric jet engine test cells are equipped with a unique pneumatic rubber door seal. Mounted on door perimeter, this seal is designed to expand proportionally and insure a perfect seal over its entire sealing surface *including the corners*. Not only does this gasket dampen the noise but it permits more accurate testing through quieter working conditions.

Continental engineers developed this pneumatic gasket for this and similar applications. Compounded of special flex-resistant rubber, this versatile gasket can be operated with intermittent flexing cycle *or* as a continuous seal—can be adapted to various other types of doors—for *either* pressure or vacuum rooms.

The design of this gasket typifies the engineering skill offered by Continental. When you need "engineered rubber parts"—molded or extruded—enlist the service of specialists—consult Continental.

Engineering Catalog.

In addition to custom-made parts, Continental offers an extensive line of standard grommets, bushings, bumpers, rings and extruded shapes. Hundreds of these are shown in the No. 100 Engineering Catalog. Send for a copy or refer to it in Sweet's Catalog for Product Designers.

Another achievement in **RUBBER**
engineered by **CONTINENTAL**

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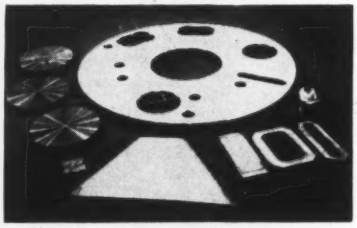
For more information, turn to Reader Service card, circle No. 481

America, the polyethylene chutes last longer because they do not rust or corrode, have good resistance to abrasion and do not allow concrete buildup.

Magnesium Oxide Key to Cold Cathode

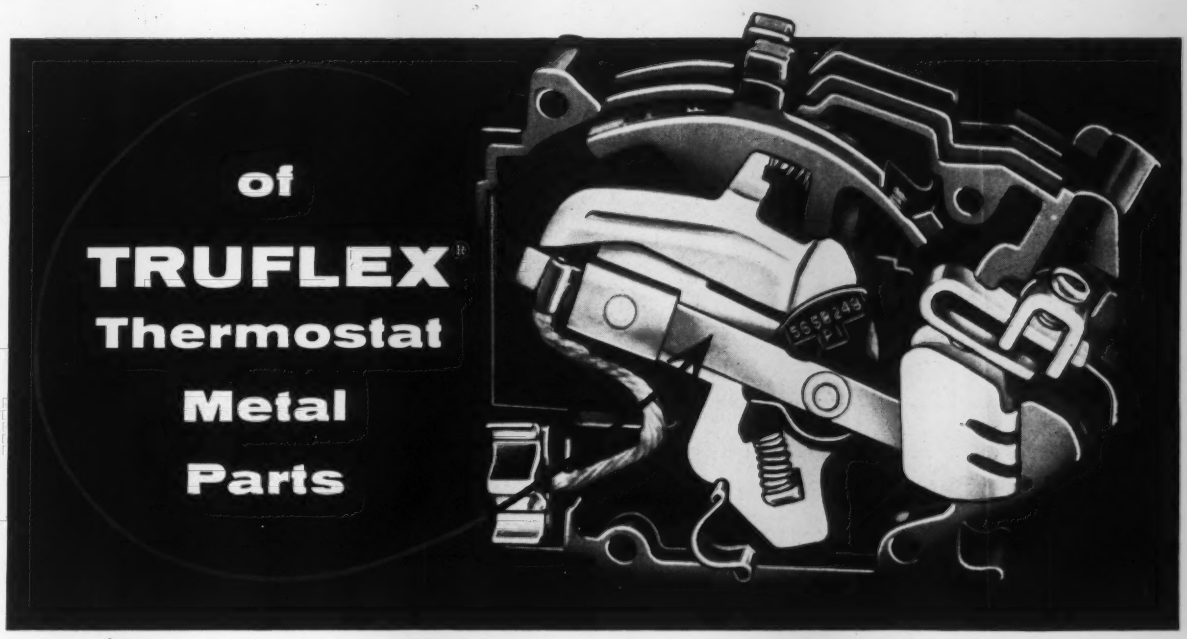
A tiny nickel cylinder coated with porous magnesium oxide is the key to the development of a new long-lasting, cold cathode electron tube. Developed jointly by the U.S. Army Signal Corps and Tung-Sol Electric, Inc., the tube is said to be capable of outlasting the equipment in which it is used.

Principle behind the tube's efficiency is the replacement of heat by a high voltage field to produce electron flow. In ordinary tubes, a hot cathode element is required to generate electron flow to the tube's plate. Heating of the element not only uses up a large percentage of the available power, but requires the use of additional circuits or extra batteries. In addition, the tubes do not operate immediately; a few sec-

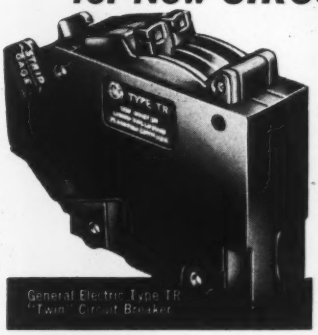


Largest stainless plates—Shown above is the major part of a special stainless steel order placed by Argonne National Laboratory for some atomic energy equipment. To fill the order, G. O. Carlson, Inc., had to produce what are said to be the world's largest stainless steel plates. The two plates, made of type 304 stainless, measured approximately 451 x 184 x 2 in. thick and weighed over 49,000 lb each. The two half-circles and several of the other parts shown were made from the plates. The entire order, which totaled nearly 100,000 lb, was flame and abrasive-cut to meet specific requirements.

Accurate, Consistent Performance



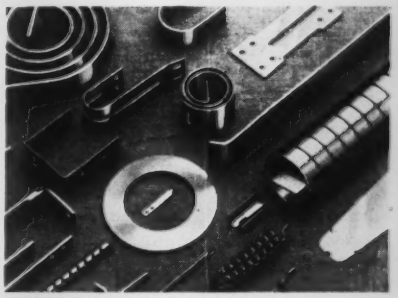
Meets General Electric's High Material Performance Requirements for New CIRCUIT BREAKERS



The new General Electric "Twin"* Circuit Breaker for household applications combines two rugged breakers into a single one-inch case to allow up to twice as many circuits per load center. Because quality and dependability are a must, General Electric Circuit Protective Devices Department used TRUFLEX Thermostat Metal parts in their Type TR "Twin"* Circuit Breakers.

TRUFLEX is available in cut strips or long-length coils to meet your needs, or can be furnished in formed elements or completed assemblies fabricated to the most exacting parts' specifications. Either way you get accurate, consistent performance with TRUFLEX because every repeat order is an exact duplicate of the original — dependably uniform in activity, temperature range, electrical and corrosion resistance.

To new or regular users of thermostat metal, Metals & Controls has much to offer — over 60 types of TRUFLEX Thermostat Metal (resistivity from 15 to 850 ohms per c.m.f.) — complete technical literature on TRUFLEX — help with parts design — calibrated samples. Our competent field engineers will gladly call at your request. No obligation. Write today.



A few typical TRUFLEX formed elements fabricated for many Metals & Controls' customers.

*"Twin" Registered Trademark General Electric Company

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GENERAL PLATE PRODUCTS: Clad Metals • Electrical Contacts • Truflex® Thermostat Metal • Platinum Metals • Reactor Metals • Radio Tube & Transistor Metals

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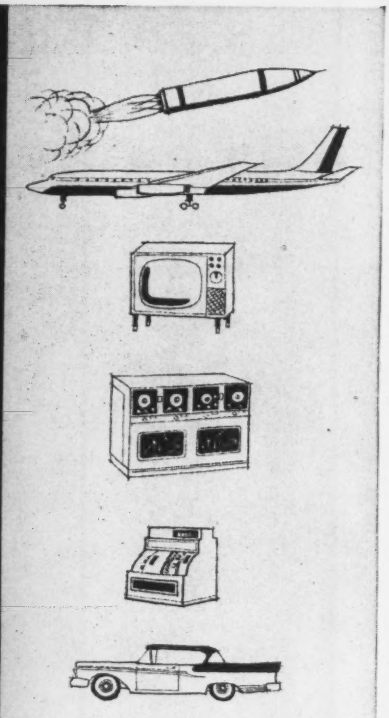
one product ties all these together...



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onds is required for warm-up of the heater element.

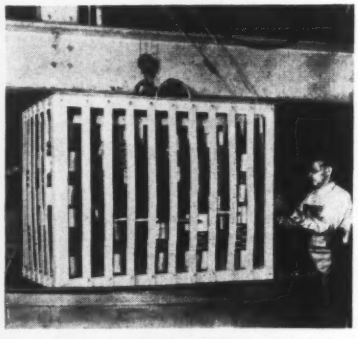
With the new tubes, operation is immediate and more efficient. Here's how it works: The layers of magnesium oxide deposited on a nickel cylinder are bombarded with electrons possessing sufficient energy to produce secondary emission. The secondary electrons are similar to those emitted from a filament-heated cathode. However, when the primary electron beam is turned off, with voltage still applied to the tube's plate, the magnesium oxide layers continue to emit electrons. Theoretically, no special heater element is necessary, and the cathode can be run on a small portion (about ¾ w) of the direct current used to supply power to the plate. (Present models use a tiny tungsten cathode starter element; according to Tung-Sol, however, this will be eliminated in future production models.)

Possible applications for the cold cathode tube include: audio output amplifiers, electron gun for flat cathode ray tubes for television or radar, and any number of electronic devices requiring instant starting, long life and low power.

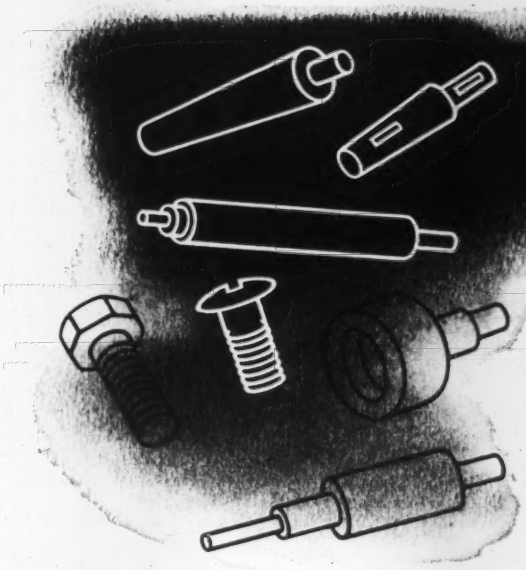
Stainless Baskets Best for Pickling

The switch from a plastic-coated carbon steel to Carpenter 20 stainless steel has resulted in a 25-time increase in the life of pickling baskets.

The baskets, used to carry stainless steel bellows-type expansion



***Stainless steel** pickling baskets last up to 25 times longer than plastic-coated carbon steel baskets.*



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Prehardened

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Here's the high strength steel that cuts engineering and maintenance problems to the bone on maintenance and machine tool applications. Unexcelled strength, good toughness and increased wear resistance—these are the advantages of VISCOUNT 44, even when exposed to temperatures up to 1000°F.

More important, risk of size change and distortion of critically-engineered parts during heat treatment is completely eliminated. VISCOUNT 44 is furnished prehardened at Rockwell C 42-46 . . . it's practical to machine . . . easy to work!

NOMINAL ANALYSIS

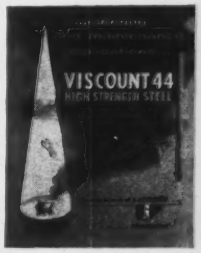
Carbon	.40	Chromium	5.00
Silicon	1.00	Molybdenum	1.20
Manganese	.75	Vanadium	1.00

plus Alloy Sulphides

MECHANICAL PROPERTIES

Furnished Hardness	RC 42-46
Tensile Strength	180,000-220,000 psi
Yield Strength (0.2% offset)	160,000-200,000 psi
Reduction of Area	40-50%
Elongation, 2"	10-15%
Coefficient of Expansion 80-1000°F	7.0 x 10^{-6} inches/inch°F

Have a high strength steel problem? Call a Latrobe sales engineer today! Or, send for VISCOUNT 44 literature.



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HIGH PRESSURE
PLASTIC
LAMINATES
FOR
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FARLITE®

GRADE: FARLITE P-633-GS			SPECIFICATION: NEMA XXXP	
PROPERTY	CONDITION	UNIT	SPECIFICATION VALUE	REPRESENTATIVES TEST VALUE
ELECTRICAL				
Dielectric Strength	A	Min.	60.0	80.0
S/S Parallel To Lamination	D-48/50	KV.	15.0	40.0
Dissipation Factor	A	Max. 10 Cycles	0.035	0.028
	D-24/23		0.035	0.035
	D-48/50		0.05	0.038
Insulation Resistance	C-96/35/90	Meg.		50,000
MECHANICAL				
Impact Strength IZOD - Edgewise	E-48/50	Min. Ft. Lb. Per Inch of Notch L	0.35	2.30
		C	0.30	1.40
Flexural Strength Flatwise	A	Min. P.S.I. L	12,000	16,000
		C	12,000	14,000
Hot Solder	A		580°F - 7 Sec.	No Blister

PLASTICS DIVISION FARLEY & LOETSCHER MFG. CO. DUBUQUE, IOWA

For more information, turn to Reader Service card, circle No. 548

joints through pickling and/or passivating baths after annealing or forming, are subjected to either 1) hot sulfuric acid followed by cold hydrofluoric-nitric acid (pickling plus passivating) or 2) nitric acid alone (passivating).

According to Zallea Bros., manufacturer of the expansion joints, previously used plastic-coated carbon steel baskets were frequently damaged in handling. The coating itself was often abraded away from the steel structure, exposing the metal to corrosive attack. And the pickling solution was often entrapped under ragged areas of torn plastic, causing further corrosion between the coating and the steel.

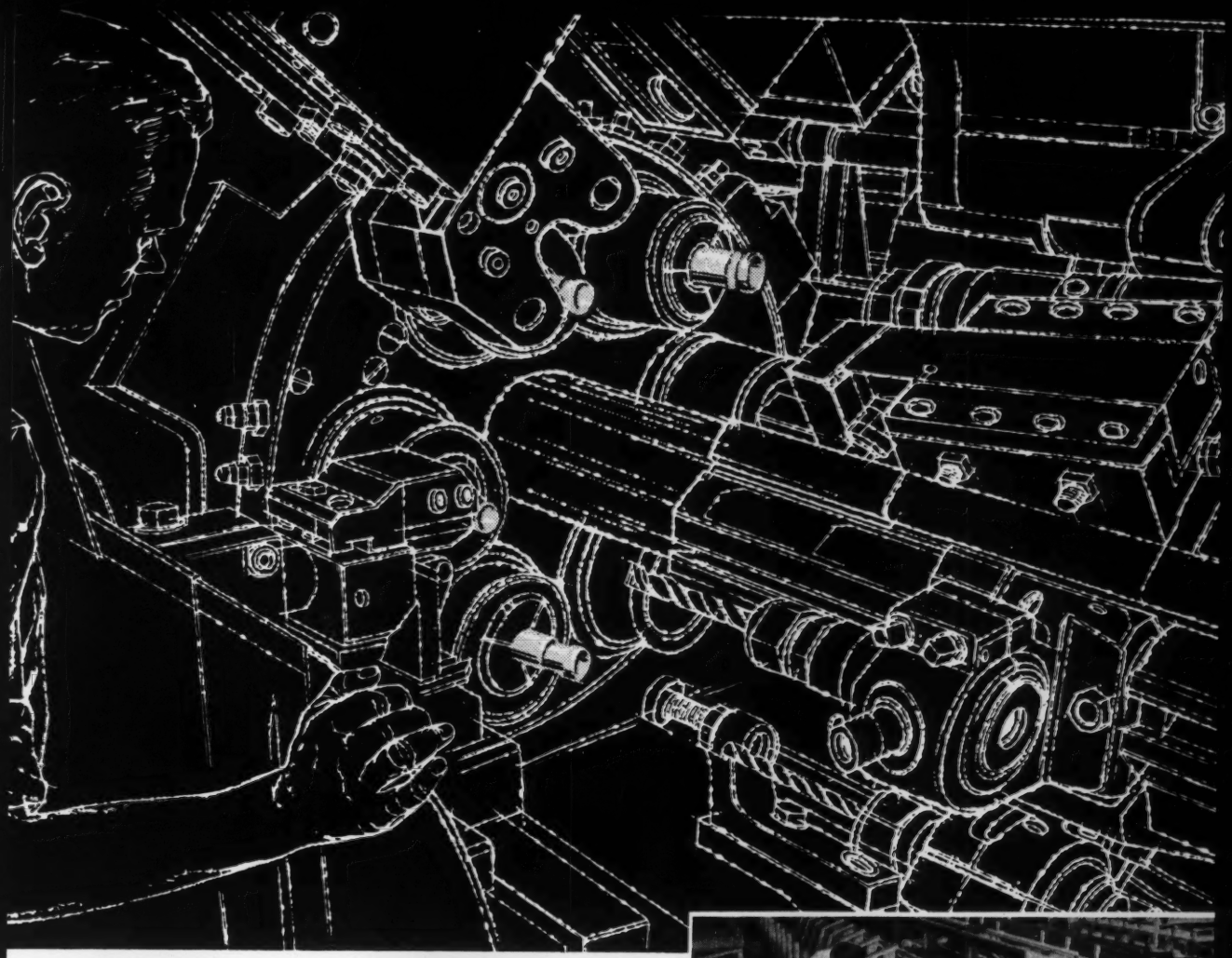
Because stainless steel is relatively resistant to corrosion from the pickling solutions, no plastic coating is needed. Morover, since the new baskets last for several years, as compared to only 6 months for the previously used baskets, only one basket is necessary. Previously, it was necessary to keep two baskets on hand so that one could be in service at all times.

Urethane-Filled Bronze Cuts Destroyer Weight

Urethane foam is being used to fill hollow bronze castings in a unique experimental destroyer project.

According to the U. S. Navy, the USS Witex has been outfitted with huge open-end cylinders in an experiment designed to improve the ship's performance. If made of solid bronze, the cylinders would cause the stern to float considerably lower and would impose an undesirable load on the power source.

In order to reduce weight and still maintain structural support, the hollow cylinder walls were filled with a special urethane foam formulation (density and characteristics withheld). According to Dayton Rubber Co., suppliers of the foam, selection was "based upon the foam's adhesion, compressive strength and ease of application." In addition to reducing weight and providing structural support, the foam assures adequate buoyancy in the event of flooding.



The Ultimate Test

The ultimate test of quality in stainless steel bars takes place in screw machine production, where every bar is literally cut to pieces.

The Perry-Fay Company, Elyria, Ohio, a leader in screw machine production, has been subjecting J&L bars to this demanding production-line test for more than a year, **without a single failure, without a single reject.** Perry-Fay reports: "We consistently get superior surface finish, closer tolerances, fully formed rolled threads with J&L stainless bars."

Whether you need stainless steel bar stock for high-speed, high-production operations, or a single bar for extraordinary requirements, turn to J&L. J&L leads the industry in melt shop standards for stainless steel, the point where quality starts—and new production profits begin.

For more information, turn to Reader Service card, circle No. 465

Careful attention to every production detail is the key to J&L quality.

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#5 HONEYCOMB AS AN ENERGY ABSORBER

While honeycomb materials are used principally in light-weight, high-strength sandwich structures, increasing emphasis has been placed on the use of honeycomb to control forces exerted on decelerating objects. Such control is highly desirable in cushioning the impact of air-dropped supplies, protecting instrumented missile assemblies, providing impact-limiting linkages in landing gear structures, packaging fragile items, and protecting human occupants of high speed vehicles.

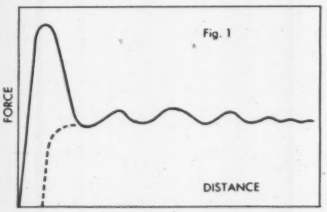
The Problem

Instances requiring impact energy absorption are generally typified by low tolerable deceleration rates for the structure or its contents, high impact velocities, and small maximum allowable stopping distances. Such absorbers as mechanical springs, sponge or solid rubber, foams, cork, and wadding generally exhibit spring characteristics, in that the force transmitted through these absorbers to the object being stopped increases continuously through the distance in which the absorbers contract. In addition, many of these materials do not absorb energy, but merely store it for release as rebound energy.

If an absorber could exert a relatively constant non-rebound force throughout the entire stopping distance, that distance could be shortened, or alternately, the maximum force acting on the object in the same stopping distance could be materially reduced.

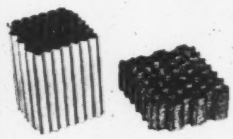
Advantages of Honeycomb

Honeycomb core materials tend to follow such a constant force curve, as shown in Figure 1.



The initial peak on the curve represents the point at which compressive failure begins. This peak can be lowered by prestressing the core to produce slight initial compressive failure. When subjected to further or subsequent loading, the prestressed core proceeds immediately to carry the crushing load, as shown by the dashed line curve in Figure 1.

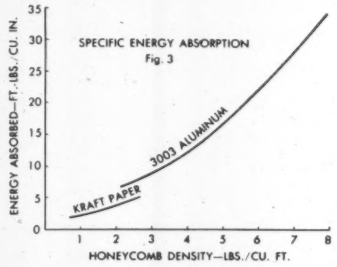
Figure 2 illustrates the appearance of aluminum honeycomb core before and after compressive failure.



By designing a honeycomb core assembly with a specified cell depth this constant force can be applied over a predetermined stopping distance.

Available Materials

These principles apply to aluminum and paper honeycomb, and most similar honeycomb core materials fabricated from ductile metals and fabrics. Figure 3 indicates the general range of energy absorption capacity available in aluminum and paper materials.



These capacities can be further increased by filling the cells with various foamed materials.

Optimum Solution

The choice of materials by the designer will depend upon the particular requirements of the application. But it seems apparent that the utilization of honeycomb offers the optimum solution—in terms of weight and volumetric efficiency—to many types of energy absorption problems.

Others in This Series. Copies sent on request

1. **Honeycomb Sandwich Panels**
2. **Honeycomb Sandwich Materials**
3. **Successful Honeycomb Sandwich Design**
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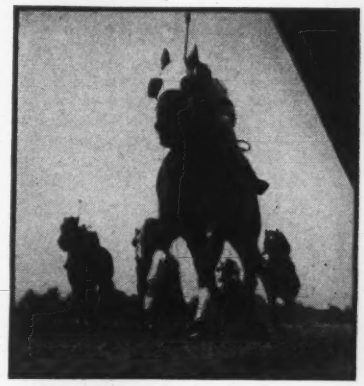
IT'S THE FINISH THAT COUNTS



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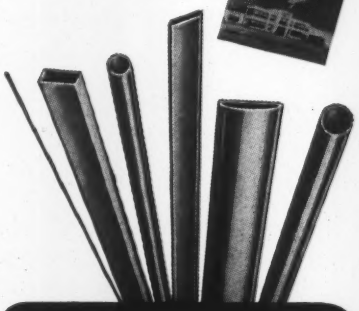

PRECISION TUBE COMPANY

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News OF INDUSTRY

SAMPE Sets Sealants Symposium

A special three-day symposium on "Sealants and Sealing of Aircraft, Missiles and Electrical Components" has been scheduled for Oct 28-30 at the Inst. of Aeronautical Sciences Bldg., Los Angeles.

Two years' planning

The symposium, sponsored by the Society of Aircraft Materials and Process Engineers (SAMPE), culminates two years of planning. The technical program has been prepared by men who both design systems to be sealed, as well as design the sealants.

According to SAMPE, knowledge and techniques involved have been highly specialized and confined to relatively few persons. The symposium should go a long way toward providing a general source of information.

Variety of subjects

Some of the subjects to be covered are: properties of high temperature sealing compounds; room temperature curing systems for fluoroelastomers; new experimental polymers for sealing applications; high temperature sealants for protection of structural plastics against oxidative degradation; recent developments in polysulfide polymers; developments in urethane elastomers; environmental testing; high temperature silicone sealants; silicone rubbers; effect of nuclear radiation on sealants; electrical sealing; and seal design.

The Society, which has been in existence for about 15 years, will meet on Tuesday, Oct 27, to discuss formation of a national organization. For further information about the Society, contact E. F. Winkle, Chemical Industries, 557 E. Walnut St., Pasadena, Calif.

For further information about the symposium, contact SAMPE, P. O. Box 39632, Griffith Station, Los Angeles 39.

ASTM Committee to Spec Polyolefins

Because of the considerable increase in production and use of polyethylene, polypropylene and other members of the polyolefin family of high polymers, the American Society for Testing Materials has decided to establish a new subcommittee to develop specifications for these materials.

The subcommittee will operate as part of Committee D-20 on plastics, which has already developed ASTM D1248 covering present industrial types and grades of polyethylene.

Other recent developments announced by Committee D-20 include:

1. A new tentative method of test for flammability of plastics foam and sheeting (D1692-59T). This new test supplements several other flammability tests which have been available for some time and provides the first procedure covering all cellular plastics.

2. New standards for rigid PVC and polyethylene pipe. These should be available toward the end of the year.

3. An approved specification for threading reinforced plastics pipe in sizes ranging from 1.5 to 20 in.

Group to Study Lead for Anti-Vibration Use

As a result of "intense interest in the control of vibration in buildings and machinery," the Lead Industries Assn. has initiated an ex-

METAL SHOW—See pp 21-27 for complete details on registration, technical program and exhibitors at the 41st National Metal Exposition and Congress, Nov 2-6, in Chicago.

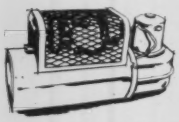
When you're choosing a protective coating...

HOW HOT IS YOUR HOT?

A Nose Cone Gets Hot

When conventional organic finishes were used in Chrysler Redstone Missile tests, they ignited and disintegrated under simulated re-entry conditions. Sicon survived because it possessed the inherent heat resistance to meet performance requirements. This has been confirmed in large scale tests and actual missile firings.

A Truck Heater Gets Hot



A porcelain type coating used on a truck heater failed because it could not stand the thermal shock of rapid heating and cooling. The same heating (550°-600°F.) and cooling left Sicon's film integrity unaffected.

A Tractor Engine Gets Hot

A farm equipment manufacturer used a bright organic red color on their standard equipment. The coating on the engine parts, which were subjected to high temperature, quickly decomposed. Midland engineers developed a matching bright Sicon Red which retained its color and gloss and protected the hot spots on the engine.

How HOT is your HOT?

Sicon possesses the flexibility of ordinary organic finishes and the heat resistance of ceramic coatings—up to 1000°F. in black or Aluminum; up to 550°-600°F. in decorative colors. Upon inquiry a sample Sicon formulation for testing your "hot" requirements will be prepared at no obligation. Send details of your "hot spot" problem today to Dept. J-1.

Sicon®

HEAT RESISTANT FINISH

A Silicone Product of

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News OF INDUSTRY

tensive research project aimed at developing engineering data on the use of lead for this purpose.

According to the association, past applications of lead for anti-vibration purposes have been based primarily on experience and empirical information. Few engineering data have been available, for example, on the actual effectiveness of lead pads at various loadings and vibration frequencies.

". . . We already know from experience that (lead) works well under certain conditions," points out Dr. Schrade F. Radtke, LIA research director. "The advantage of lead is its ability to support relatively heavy loads and its great durability as compared with competitive materials used for this purpose." Main goal of the research project will be to develop concrete, reliable engineering data.

Society of Rheology Will Meet Nov 4-6

The Lehigh University campus will be the site of the 30th anniversary meeting of the Society of Rheology, Nov 4-6.

Over 200 leading chemists and physicists will discuss the mechanical behavior and structure of matter. Technical reports will be presented on measurement of the deformation and flow of matter, and the interpretation of the physical data in functional terms.

Committee to Study Materials Research

The National Academy of Sciences–National Research Council has appointed a 14-man committee to determine how materials research and development can be accelerated to meet the increasing demands of industrial progress and national defense.

According to Dr. Detlev W. Bronk, Academy president, the committee will examine the total materials research needs of the country. Specifically, the committee has been asked to: 1) determine how more rapid and effective progress in materials

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New FLUOREL Brand Elastomer is a highly fluorinated synthetic rubber that successfully resists corrosive chemicals, fuels, solvents, and ozone

FLUOREL Elastomer is rated for continuous long-time service at 400° F . . . tolerates 600° F temperatures, and higher, for reduced periods under some service conditions. Ease of processing, non-combustibility, and excellent resistance to compression set are other outstanding features.

FLUOREL Elastomer greatly extends the performance range of applications requiring elastomeric materials. Its many exciting possibilities make it an important member of the ever-expanding family of 3M organic fluorine compounds. For complete data, write: 3M, Chemical Division, Dept. KAR-109, St. Paul 6, Minn.

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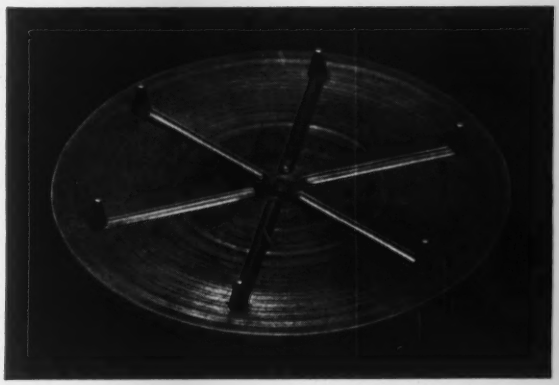
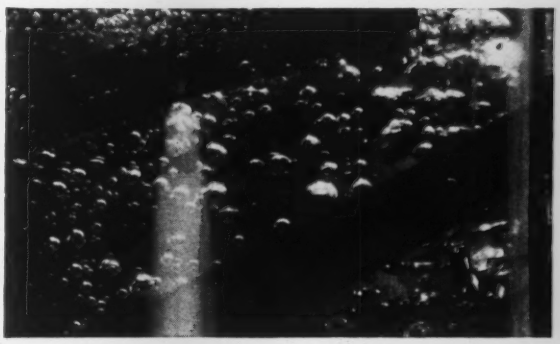


EASE OF PROCESSING is shown by this disc. Note the reproduction of machine marks from mold surface. FLUOREL Elastomer can be readily mold processed on standard rubber compounding and fabricating equipment. It may be molded, extruded and bonded to most metals.



WHEREVER THE HEAT'S ON, put FLUOREL Elastomer to work for you. It's in use now or under evaluation in the missiles and aircraft, automotive and chemical processing industries for oil seals, "O" rings and gaskets. Other suggested uses: fire walls, air ducts, fuel cells, fuel and hydraulic hose, diaphragms and tank linings.

CHEMICAL DIVISION

MINNESOTA MINING AND MANUFACTURING COMPANY

. . . WHERE RESEARCH IS THE KEY TO TOMORROW

3M COMPANY

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the BIG JOBS go to Frenchtown

Speaking of firsts . . . here are some of the *largest high alumina ceramic parts ever produced!* The planning and execution of this critical assignment is representative of our ability to resolve the most difficult and demanding ceramic problems, and to manufacture the ceramics to satisfy specific requirements.

We specialize in high alumina ceramics, metallized ceramics, ceramics-to-metal seals, superior wear resistant ceramics, and "tailor-made" body compositions.

The next time you are faced with a problem involving ceramics, *large or small,* get in touch with us. We will be glad to survey your requirement and recommend the most practical and economical solution.

Literature is available on Frenchtown materials and products. Copies, containing a wealth of engineering data, will be sent upon request. Write *today.*

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FRENCHTOWN, NEW JERSEY

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News OF INDUSTRY

research can be realized through increased financial support, administrative or organizational steps, and improved coordination of effort; 2) consider both basic and applied research carried on for both defense and nondefense purposes in governmental, industrial, academic and other research institutions; and 3) consider the resources of raw materials, personnel and facilities.

Engineers

Robert E. Deatz has been named to the newly created position of manager, product planning, Girdler Process Equipment Div., Chemetron Corp.

Heinz Hanau has been appointed director of engineering and research, Western Div., Industrial Tectonics, Inc.

Fred K. Quigley, Jr., has been named staff manager of coating materials, Plastics Dept., Dow Chemical Co.

Karl Baumler has been appointed manager of manufacturing, Pittsburgh Corning Corp.

Millard A. Nelson has been appointed engineering consultant, and **Roland L. Coit** has been named manager of engineering, Heat Transfer Apparatus Dept., Steam Div., Westinghouse Electric Corp.

Kenneth P. Seeger is now chief metallurgist, Precision Extrusions, Inc.

Frank S. Bonham has been named technical director, Fome-Cor Corp., Springfield, Mass.

Dudley P. Biggs has been appointed manager, Custom Fabrication Dept., Carl H. Biggs Co.

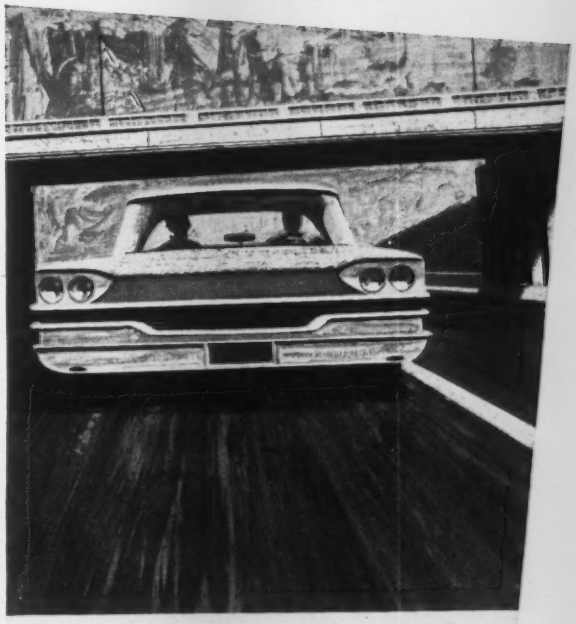
C. E. Newcomb has been appointed manager, research facilities planning, Crucible Steel Co. of America.

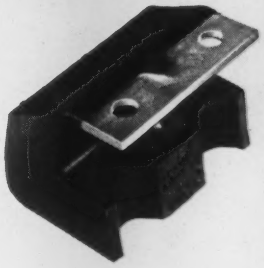
Tullio Tognola has been named assistant director of engineering, Scintilla Div., Bendix Aviation Corp.

Herbert H. Fink has been named vice president, development, B. F. Good-

AWARDS COMPETITION—Entries for the 4th annual Awards Competition for the Best Use of Materials in Product Design are due Feb. 1, 1960. See pp 109-112 for full details.

FROM UNBREAKABLE CASES





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WHENEVER CUSTOM-MADE RUBBER PRODUCTS ARE CALLED FOR, CALL FOR YOUR FIRESTONE TECHNICAL SERVICE MAN

Taking bottlenecks out of production lines is a specialty with your Firestone Technical Service Man. He's adept at handling varied production problems ranging from shatterproof battery cases to motor mount bases. And—at the drop of an invitation—he'll meet *your* individual needs with a custom-tailored plan! He'll analyze your specifications expertly and make precise recommendations. Then he'll put Firestone's complete rubber and latex custom-production service at *your* service.

Firestone's extensive laboratory facilities develop the exact compounds and product designs to fit your requirements. And Firestone's mass-production facilities deliver close-tolerance, high-volume output at reasonable costs.

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Firestone RUBBER & LATEX PRODUCTS COMPANY
FALL RIVER, MASSACHUSETTS

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PRODUCT MANUFACTURED

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CITY

ZONE STATE

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Rubber-To-Metal Bonding

"APCOTITE" is exclusive with Acushnet Process Company — quality bonding of Silicone and all types of rubber polymers to all metals for the lifetime of the part.

To obtain maximum strength, toughness and resiliency, shock and vibration absorption, sound abatement, electrical insulation, resistance to corrosion and abrasion, specify "APCOTITE".

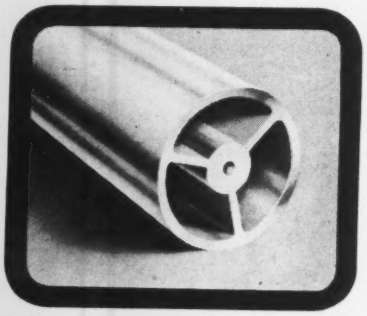
Acushnet PROCESS CO.

Send for Acushnet brochure "Rubber-To-Metal Bonded Parts", a helpful guide giving detailed information about this modern adhesion process.

Address correspondence to 750 Belleville Avenue, New Bedford, Mass.

WHITE METAL extruded this complex spool member in magnesium alloy AZ-31B.

It has three radial support arms, interconnecting hub & external shell. Cylindrical surface takes high finish. 2-1/16" OD; 0.12" wall.



WHITELIGHT MAGNESIUM

see WHITE METAL for your complex MAGNESIUM ALLOY EXTRUSIONS

WHITE METAL . . . and WHITE METAL alone . . . has the engineering experience and integrated magnesium facilities to turn many "impossible" designs into reliable, spec-meeting extrusions . . . at **lower** cost. Versatile WHITELIGHT magnesium gives you a virtually unlimited choice: any length, any shape, any alloy, any finish.

Call on our Sales Engineers for help in solving your complex shape problems. No obligation, of course. WRITE, WIRE OR PHONE TODAY!

Send for fact-filled brochure on properties, uses, etc. of WHITELIGHT MAGNESIUM

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One of the World's Largest Producers of Magnesium Alloy Mill & Finished Products

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News OF INDUSTRY

rich Industrial Products Co., a division of B. F. Goodrich Co.

Dr. Julian J. Hirshfeld has been named group leader, finish applications research, Chemstrand Corp.

Victor Del Greco has been named superintendent of micrometer assembly operations, J. T. Slocomb Co.

Adolph Vlcek, Jr., has been appointed director of manufacturing, Baltimore Div., Martin Co.

Edmond S. Bauer has been appointed assistant director of development, Plastics Div., Monsanto Chemical Co.

W. E. Montgomery has been named chief engineer, Carbide Div., Firth Sterling Inc.

Dr. Justo B. Bravo, Dr. Meyer M. Markowitz, and **Lawrence J. Reader** have been named group leaders of New Products and Processes, Thermodynamics and Physical Chemistry, and Technical Services, respectively, Foote Mineral Co. **David W. Mitchell** has been named coordinator, research and production.

J. R. South is now product manager, Urethane Dept., Dayton Industrial Products Co., a division of Dayton Rubber Co.

Henry C. Nelson has been appointed superintendent of General Electric Co.'s Anaheim, Calif. plant.

Hubert Bennett has been named director, applications engineering, McCormick Selph Asso.

Dr. Carlisle M. Thacker has been named technical director, Taylor Fibre Co.

D. Rex Scott has been appointed general manager of Robertshaw-Fulton Controls Co.'s Western Research Center, Anaheim, Calif.

S. J. Becker has been named vice president and chief engineer, Spring Div., Borg-Warner Corp.

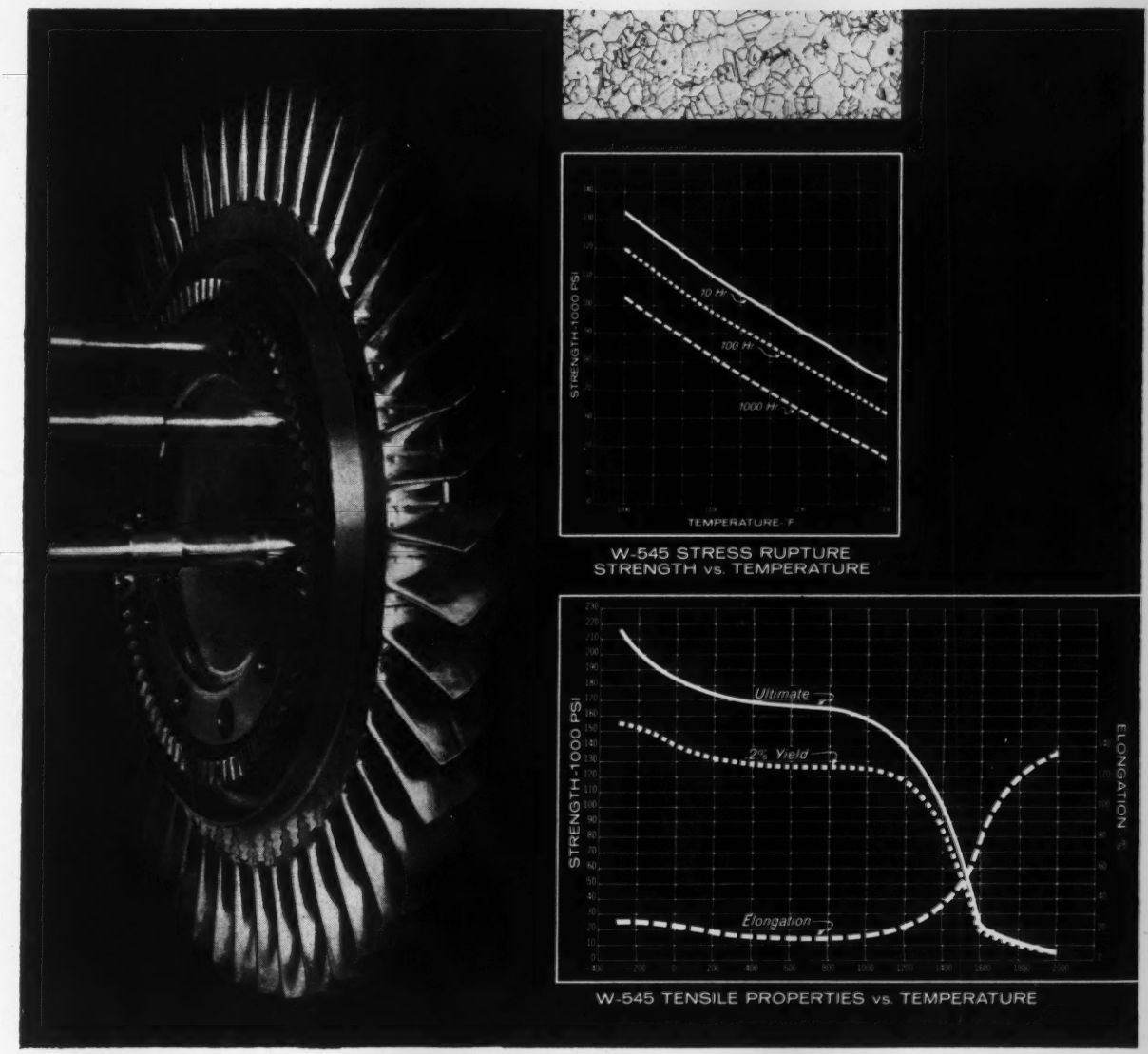
Dr. Henry Rose has been appointed director of research, Plasteel Products Corp. and its subsidiary, Laurel Research Corp.

Jerry S. Butler has been named assistant chief engineer, Key Resistor Corp.

Frederick R. Matthews is now manager, Silicone Specialties Div., Dow Corning Corp.

C. P. Cairelli has been named chief engineer, M. H. Rhodes, Inc.

Francis C. Mears has been named project engineer, Thompson-Ramo-



W-545 STRESS RUPTURE STRENGTH vs. TEMPERATURE

W-545 TENSILE PROPERTIES vs. TEMPERATURE

NEW HIGH-TEMPERATURE ALLOY W-545 HAS 20% MORE STRENGTH

Twenty percent more strength at 1200°F from this turbine disc gave added dependability for a Westinghouse customer using W-545. This new high-temperature alloy will withstand higher stress levels than similar alloys at the same operating temperatures . . . or it will withstand equivalent stress characteristics at 100°F higher operating temperatures.

Critical high-temperature parts can be made from this material that have excellent strength-to-weight ratios and can be used at temperatures up to 1350°F . . . excellent characteristics at —300°F.

W-545 has proven itself superior for turbine wheels . . . compressor discs and shafts . . . combustion chambers . . . housings and skin materials. W-545 is nonmagnetic and has a low strategic alloy content, permitting ease of fabrication for fasteners . . . rings . . . spacers . . . fittings . . . brackets . . . supports and mounts.

The Westinghouse Metals Plant can furnish strip, sheet, bar, forgings and forging stock in W-545 and other wrought high-temperature alloys. Get all the information today; write: Westinghouse Electric Corporation, Materials Manufacturing Department, Blairsville, Pennsylvania.

J-05010

YOU CAN BE SURE...IF IT'S

Westinghouse

WATCH "WESTINGHOUSE LUCILLE BALL-DESI ARNAZ SHOWS" CBS TV FRIDAYS

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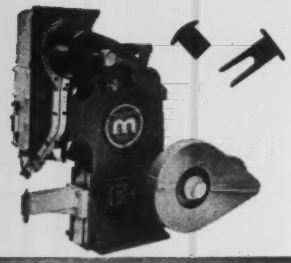
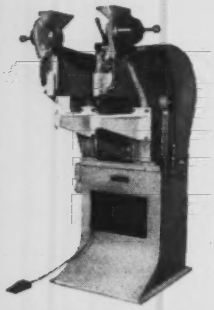
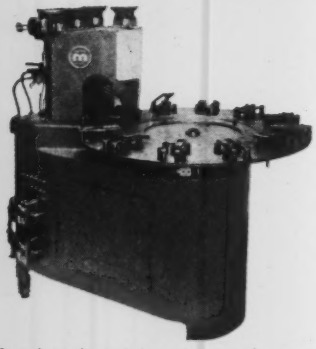


CUT RIVET ASSEMBLY COSTS



with Milford's Complete Line of AUTOMATIC RIVETERS



Can be adapted to solve nearly every fastening and assembly problem. For the answers to assembly problems... *get in touch with Milford first!*

THE MILFORD RIVET & MACHINE CO.

MILFORD, CONNECTICUT • HATBORO, PENNA.
ELYRIA, OHIO • AURORA, ILL. • NORWALK, CALIF.

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News OF INDUSTRY

Wooldridge Products Co., a division of Thompson Ramo Wooldridge Inc.

Frederick P. Huston has been appointed assistant chief engineer, Tube Reducing Corp.

Norbert Frosch is now manager, industrial styling, Columbus Coated Fabrics Corp.

John J. Cullen has been appointed product manager, engineered and molded rubber products, U. S. Rubber Co.

Companies

Studebaker-Packard Corp. has acquired **C. T. L., Inc.,** Cincinnati, Ohio.

International Harvester Co. has opened its new 455,000-sq ft Farm Equipment Research and Engineering Center in Hinsdale, Ill.

Baldwin-Ehret-Hill, Inc., is the name of a new company formed by the merger of **Ehret Magnesia Mfg. Co.** and **Baldwin-Hill Co.** Baldwin-Ehret-Hill is located at 500 Breunig Ave., Trenton, N. J.

Hevi-Duty Electric Co., a division of Basic Products Corp., has purchased **Sermax Corp.** of Milwaukee.

Langevin Div., W. L. Maxson Corp. has moved to new quarters at 475 Tenth Ave., New York 18, N. Y.

Dow Metal Products Co. is the name of a newly formed division of Dow Chemical Co.

American Metal Products Co. has begun construction of a modern research, engineering and development center in Ann Arbor, Mich.

Porter Athletic Equipment Co., a division of Waco Mfg. Co., has acquired **Kodakon Tool & Engineering Co.**

Celanese Corp. of America has organized three new companies—Celanese Fibers Co., Celanese Chemical Co., and Celanese Plastics Co.—which will operate as divisions of the parent firm.

Sparta Mfg. Co. has begun construction of a new plant addition in Dover, Ohio.

Plastic Parts Corp. has moved to new quarters at 1701 Nebraska Ave., Toledo 7, Ohio.

ACDC Electronics, Inc., has acquired **Pan-Air Electronics, Corp.,** of Burbank, Calif. Pan-Air Electronics will

MOLDED FIBER GLASS

makes the revolutionary new

White "5000" Cab

It's a radical new design, possible only with MOLDED FIBER GLASS... it is thirty-six MOLDED FIBER GLASS parts, bonded into an integral unit . . . space saving, efficient, lightweight, profit-earning.

This MOLDED FIBER GLASS cab is warm in winter, cool in summer, quiet . . . rust-proof, impervious to salt and road chemicals . . . tough, impact-resistant.

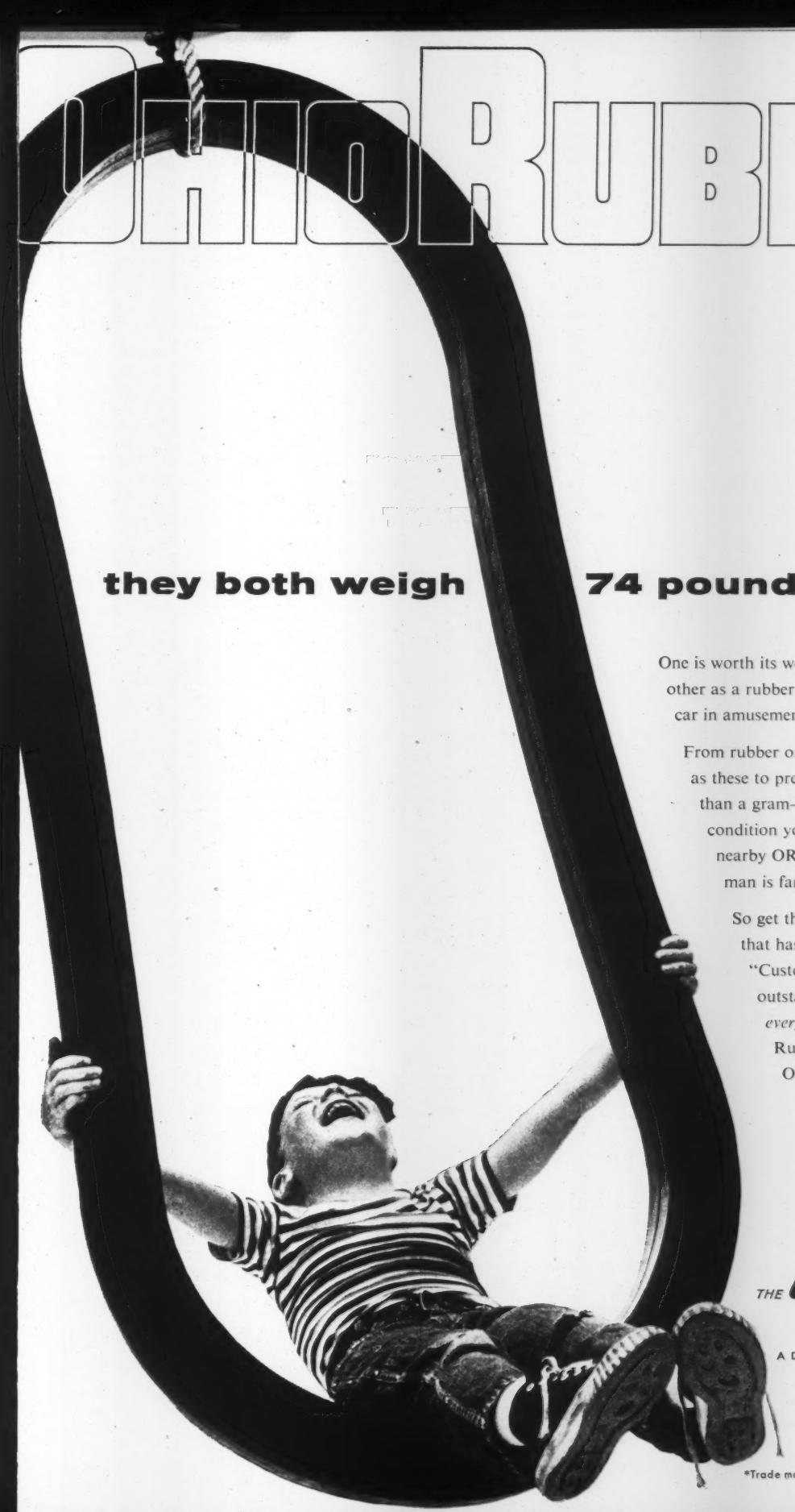
Write or phone today for cost estimates on making *your* products better with MOLDED FIBER GLASS, as matched-metal-die-molded by the world's largest, most experienced producers of fiberglass reinforced plastic.

Molded Fiber Glass Body Company

GREATEST NAME IN REINFORCED PLASTICS — MOLDED FIBER GLASS

4621 Benefit Avenue, Ashtabula, Ohio

OHIO RUBBER



they both weigh 74 pounds...

One is worth its weight in protection for the other as a rubber bumper on a "Dodgem" car in amusement parks.

From rubber or rubber-like parts as large as these to precision components weighing less than a gram—and for practically every condition you can think of . . . your nearby ORCO "Customeering"* man is familiar with them all.

So get the advantage of the experience that has put Ohio Rubber "Customeered"* components in outstanding original equipment in *every* industry. Write to The Ohio Rubber Company, Willoughby, Ohio. 9PA1

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THE OHIO RUBBER COMPANY
Willoughby, Ohio

A DIVISION OF THE EAGLE PICHER COMPANY

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*Trade marks of The Ohio Rubber Company

For almost every hardness testing requirement

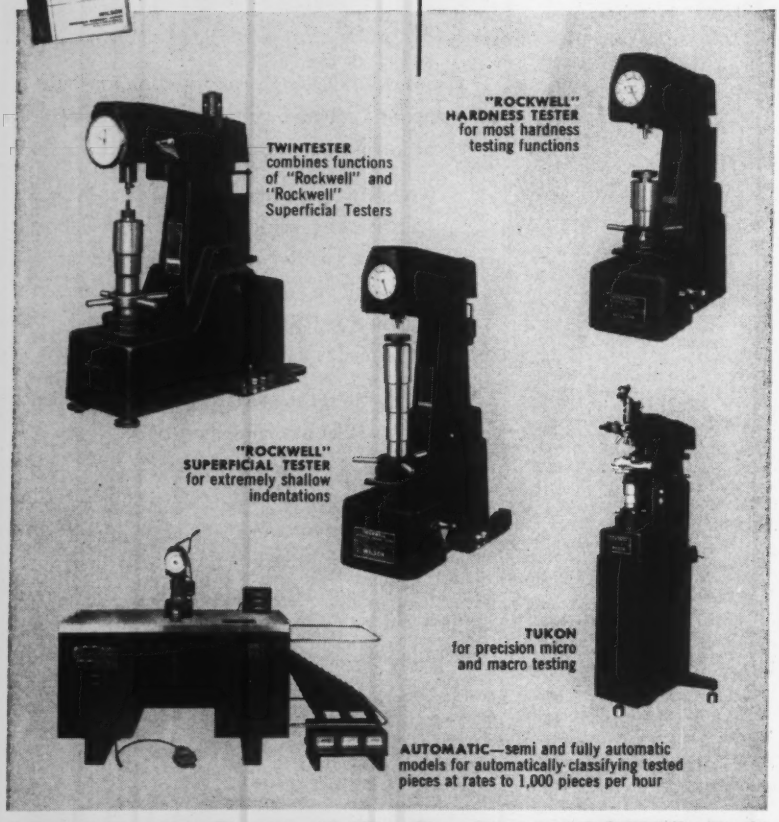
There's a Wilson "Rockwell" instrument to do the job

Wilson "Rockwell" Hardness Testers can help make your products better, stronger, longer lasting. They give reliable results on the production line, in laboratories, in tool rooms, and in inspection departments. They're as easy to use as a center punch, as durable as a machine tool, as sensitive and accurate as a precision balance. That's why Wilson "Rockwell" is recognized as the world's standard of hardness testing accuracy.

Wilson "Brale" Diamond Penetrators give Perfect Readings

A perfect diamond penetrator is essential to accurate testing. Only flawless diamonds are used with Wilson "Brale" penetrators. Each diamond is cut to an exact shape. Microscopic inspection and a comparator check of each diamond—one by one—assure you of accurate hardness testing every time.

Write for Catalog RT-58. It gives complete details on the full line of Wilson hardness testing equipment.


TWINTESTER
combines functions of "Rockwell" and "Rockwell" Superficial Testers
"ROCKWELL" HARDNESS TESTER
for most hardness testing functions
"ROCKWELL" SUPERFICIAL TESTER
for extremely shallow indentations
TUKON
for precision micro and macro testing
AUTOMATIC—semi and fully automatic models for automatically classifying tested pieces at rates to 1,000 pieces per hour

WILSON "ROCKWELL" HARDNESS TESTERS

ACCO

Wilson Mechanical Instrument Division
American Chain & Cable Company, Inc.
230-E Park Avenue, New York 17, N. Y.

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News OF INDUSTRY

be operated as a wholly-owned subsidiary of ACDC Electronics.

Kaiser Gypsum Co. will build a multi-million-dollar gypsum products plant near Albuquerque, N. M.

Telemeter Magnetics, Inc., has formed a new Components Division under the direction of Edwin R. Gamson.

American Potash & Chemical Corp. has begun production of anhydrous lithium chloride at its Henderson, Nev. plant.

R. B. Denison Mfg. Co. has moved to expanded plant facilities at 386 Broadway, Bedford, Ohio.

Thompson-Ramo-Wooldridge Products Co., a division of Thompson Ramo Wooldridge Inc., has moved to 202 N. Canon Dr., Beverly Hills, Calif.

TelAutograph Corp. has purchased **Hogan Laboratories, Inc.,** and its wholly-owned subsidiary, **Faximile, Inc.**

E. I. du Pont de Nemours & Co., Inc., will construct a metallurgical research center at its Baltimore plant.

Gorham Mfg. Co.'s Electronics Div. has added a new investment casting facility to its plant in Providence, R. I.

Horkey-Moore Asso. has begun construction of a 13,500-sq ft building at 24660 S. Crenshaw Blvd., Torrance, Calif.

Accoustica Asso., Inc., has opened its new ultrasonics plant in Plainview, L. I., N. Y.

Magnetic Metals Co. has purchased a 22-acre tract of land for the construction of manufacturing and laboratory facilities in Pennsauken Industrial Park, N. J.

Gilbert Mfg. Co., Inc., has begun a 70,000-sq ft expansion of its plant facilities at 24-20 46th St., Long Island City, N. Y.

CIBA Products Corp. has moved to new quarters in Industrial Park, Fair Lawn, N. J.

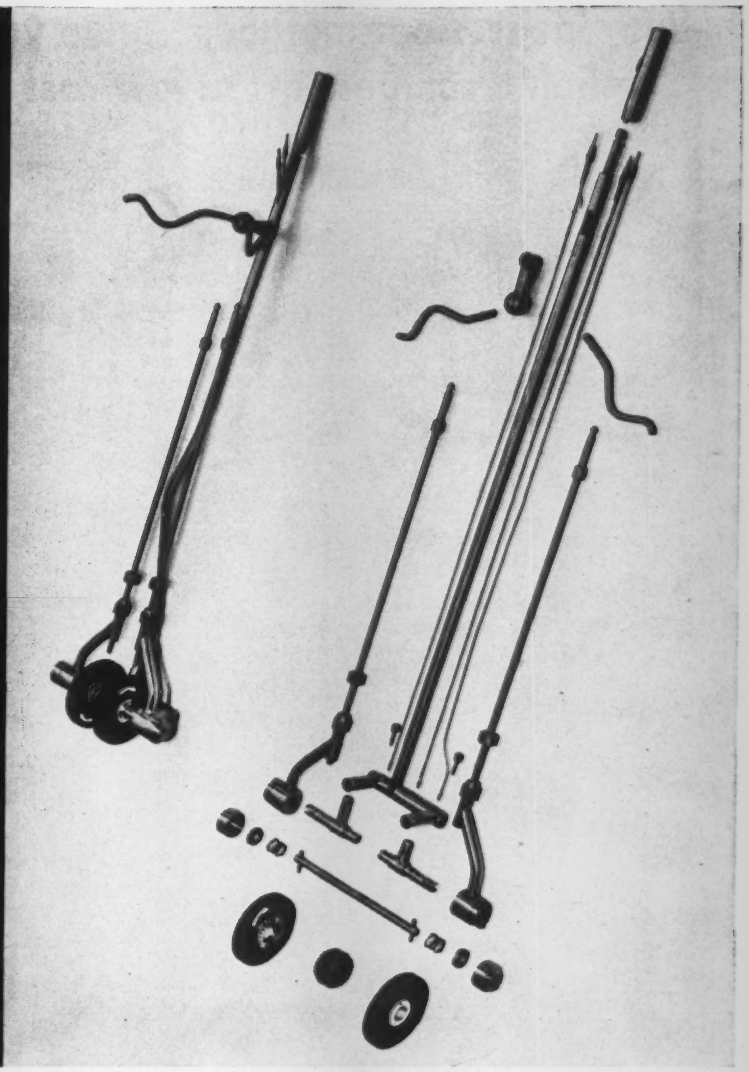
General Electric Co.'s Metallurgical Products Dept. has moved to 130 Northfield Road, Bedford, Ohio.

Vulcan Materials Co. has acquired **Ralph E. Mills Co.,** Frankfort, Ky., and **Talbott Construction Corp.** and **Talco Constructors, Inc.,** both of Winchester, Ky.

D. S. Kennedy & Co. and **Anchor Metals, Inc.,** have announced a merg-

HERE'S HOW STILL ANOTHER MANUFACTURER JOINS STAINLESS STEEL TUBING:

He uses Handy & Harman's BRAZE 630



He's one of many manufacturers and fabricators who have found—to their lasting satisfaction—that Handy & Harman silver alloy brazing is the final answer to stainless steel joining problems.

Super-Donic Manufacturing Company, Atlanta, Georgia, manufactures "Dual Arm Transmissions" for the dental industry. Most everybody has—at one time or another—seen and/or felt this unit in operation.

It is fabricated of small diameter 304 and 316 stainless steel tubing and, in its assembled form, consists of some 17 separate brazed joints. Joints must be strong, corrosion resistant and neat-appearing.

Each of the 17 joints is hand-torch brazed with Handy & Harman BRAZE 630 wire and HANDY FLUX TYPE B-1. There's no question that this is a unique application. There's no question, either, that the application is stainless steel. The ease and economy with which this manufacturer solves his problems can be just as readily applied to *your* stainless steel joining problems.

Strength, production speed, electrical and thermal conductivity, gas and liquid tightness and low cost are *natural* benefits of silver alloy brazing. We think it worth your while to learn more about this remarkable metal-joining method—we'll be glad to send you any information you ask for. Handy & Harman, 82 Fulton St., New York 38, N. Y.

FOR A GOOD START: BULLETIN 20

This informative booklet gives a good picture of silver brazing and its benefits . . . includes details on alloys, heating methods, joint design and production techniques. Write for your copy.

Your No. 1 Source of Supply and Authority on Brazing Alloys

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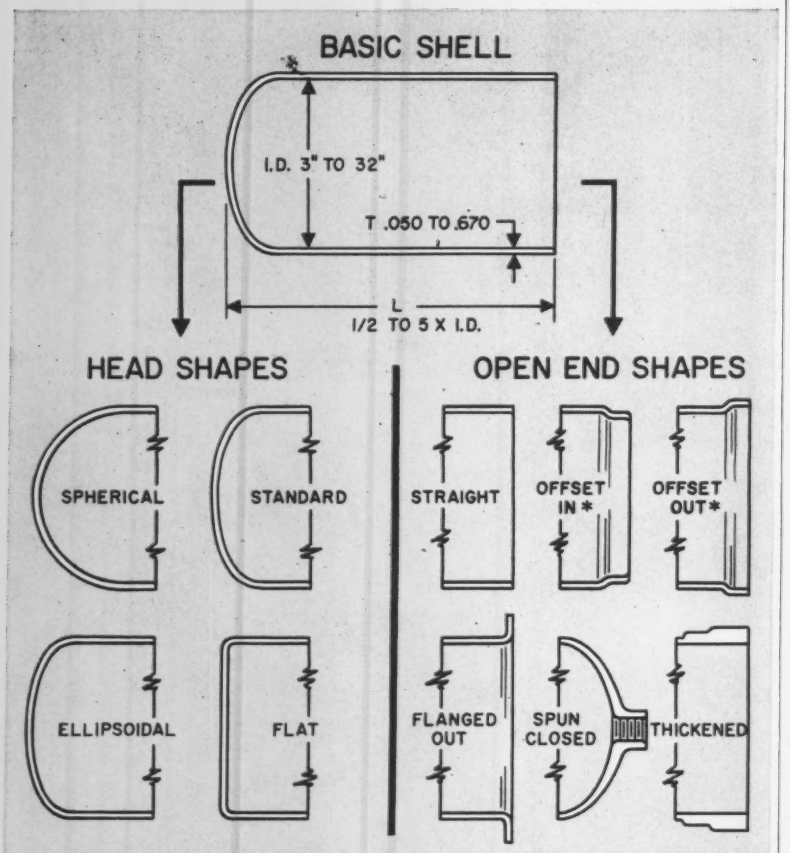
Your ideas...our methods...give you reliable components at low cost



The drawings shown here give you a simple description of the way you can use basic Hackney shells to produce a variety of seamless, lightweight, strong, low-cost rocket motor cases, gas generator housings, control actuator pressure vessels and other missile components.

The basic unit is a cold drawn, deep shell which has uniform wall thickness from top to bottom in ranges from .050" to .670". I.D.'s vary from 3" to 32". The length of the shell may be from ½ to 5 times the diameter—or up to 110".

Head shapes—spherical, standard, ellipsoidal, flat or special. *Open end shapes* offer variety—straight cut, offset in, offset out, flanged out, flanged in, spun closed or thickened. *Capacities* begin at 1 quart—go as large as 100 gallons. *Working pressures* range from 100 to 6000 psi, depending upon diameter and wall thickness.

For full details of our facilities and our methods of making components, write to the address below.

Pressed Steel Tank Company

Manufacturer of Hackney Products Since 1902

1442 S. 66th Street, Milwaukee 14, Wisconsin

Branch offices in principal cities

Hackney MILWAUKEE — HOUSTON IRON WORKS

CONTAINERS AND PRESSURE VESSELS FOR GASES, LIQUIDS AND SOLIDS

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News OF INDUSTRY

er whereby Anchor Metals will operate as a division of D. S. Kennedy & Co.

Pittsburgh Plate Glass Co.'s Paint Div. has formed a new Commercial Development Dept., with Dr. Elmer C. Larsen acting as director.

Wayne Kerr Corp. has moved to new quarters at 1633 Race St., Philadelphia 3.

Waco Mfg. Co. has begun construction of a new 48,000-sq ft plant in Schiller Park, Ill.

Carl H. Biggs Co., Inc., has moved into a new 12,000-sq ft plant at 1547 14th St., Santa Monica, Calif.

Societies

Alloy Casting Inst. has moved its offices to 1001 Franklin Ave., Garden City, N. Y.

Etched Circuits Society has elected the following 1959-60 officers: president—Wallace Moore, Sibley Co.; president-elect—Dr. Paul H. Margulies, Food Machinery & Chemical Corp.; secretary—Edward Poltrack, Barnes Engineering Co.; and treasurer—Fred Yarrington, Pettigrew & Co.

American Institute of Electrical Engineers has elected the following officers: president—J. H. Foote, Commonwealth Asso.; and vice presidents—Donald L. Greene, Gilbert Asso.; John W. Davis, Southern Bell Telephone & Telegraph Co.; Max H. Kight, U. S. Bureau of Reclamation; George T. Harness, University of Southern California; Dr. Rene Dupuis, Quebec Hydro Electric Commission; and Frederic S. Bacon, Gamewell Co.

Manufacturing Chemists' Assn. has announced the following officers: chairman of the board—J. T. Connor, Merck & Co., Inc.; chairman of the executive committee—Dr. David H. Dawson, E. I. du Pont de Nemours & Co., Inc.; and secretary-treasurer—Maurice F. Crass, Jr.; L. G. Bliss, Foote Mineral Co., has been elected to the board of directors.

Fluid Controls Inst., Inc. has elected the following officers: president—James R. Lawler, Jr., Lawler Automatic Controls, Inc.; 1st vice president—Fred Weldon, General Controls Co.; 2nd vice president—Robert McCormick, Automatic Switch Co.; cor-

IT TAKES

LEAD

To Bury Radiation In Davy Jones' Locker *PERMANENTLY*

How do you handle a modern "hot potato"?

Tissue-destroying radioactive waste is, and in the foreseeable future will continue to be a really "hot potato." It is a major problem confronting the world's rapidly growing atomic energy program. By-product waste can't be left in the back yard for the trash man—a dog's buried bone method is out. To date, the best disposal method is enclosing it in lead and dumping it into the ocean. But even at 1,000 fathoms, this practice demands A SPECIAL KIND OF "WASTE BASKET."

DISPOSAL CONTAINERS OF LEAD

Why a *lead* container? Lead is plentiful, low in cost and is the densest of all commonly available metals. This uniform density makes Pb the most efficient shield against harmful radiation known today. It is practically imperishable. Fact is, the container will last longer than the high level radioactive life of its contents.

400 pound 5 curie "cobalt 60" container and plug manufactured by Reliance Foundry, Philadelphia 24, Pa.

ST. JOSEPH LEAD COMPANY

ST. JOE

250 Park Avenue
New York 17, New York

The Largest Producer of Lead In The United States

PB-129

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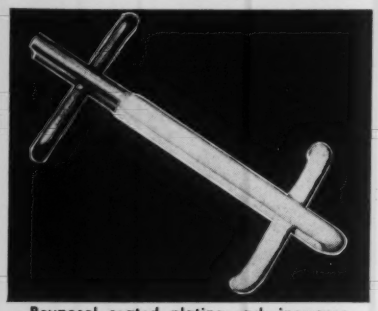
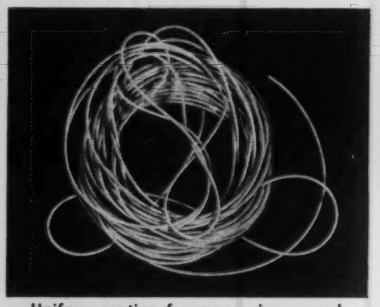
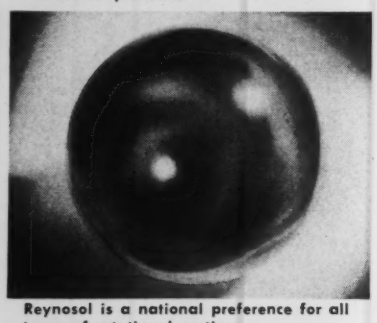


Reynosol coated plating rack increases product efficiency.

Hand tools are safer, sell better with Reynosol coating.



Uniform coating for rope, wire or cord offers no problem.



Reynosol is a national preference for all types of rotational castings.

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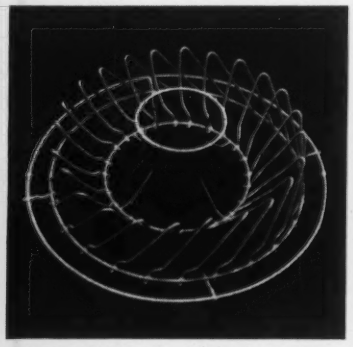

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News OF INDUSTRY

porate secretary—Eric A. Bianchi, Worthington Corp.; executive secretary—E. R. Rath; and treasurer—Paul Rogers, Jr., Skinner Chuck Co.

Alloy Casting Institute has elected the following officers: president—J. B. Dear, Duraloy Co.; vice-president—J. S. Wooters, General Alloys Co.; and executive vice president and treasurer—E. A. Schoefer.

Manufacturing Chemists' Assn. has elected the following officers: chairman of the board—John T. Connor, Merck & Co., Inc.; president and director—Gen. John E. Hull, USA (Ret.); chairman of executive committee—David H. Dawson, E. I. du Pont de Nemours & Co., Inc.; vice presidents—Thomas S. Nichols, Olin Mathieson Chemical Corp., and R. W. Thomas, Phillips Petroleum Co.; and secretary-treasurer — Maurice F. Crass, Jr.

Drop Forging Assn. has elected the following officers: president—Louis M. Fehrenbach, Indianapolis Drop Forging Co.; and vice president—Elmer W. Cress, Buchanan Steel Products Corp.

Pulp Chemical Assn. has moved to new offices at 60 E. 42nd St., New York 17, N. Y.

American Iron and Steel Institute has announced the following officers: president—Benjamin F. Fairless; vice presidents—Max D. Howell, William M. Akin, Arthur B. Homer, and C. M. White; asst. vice president—Charles M. Parker; secretary—George S. Rose; and asst. secretary—F. A. Coombs.

Meetings

AMERICAN VACUUM SOCIETY, 6th national symposium on vacuum technology. Philadelphia. Oct 7-9.

GRAY IRON FOUNDERS' SOCIETY, INC., 31st annual meeting. San Francisco. Oct 7-9.

AMERICAN SOCIETY FOR TESTING MATERIALS, 3rd Pacific Area national meeting. San Francisco. Oct 11-16.

AMERICAN INST. OF ELECTRICAL ENGINEERS, fall general meeting. Chicago. Oct 11-16.

15TH NATIONAL ELECTRONICS CONFERENCE, American Inst. of Electrical Engineers, Illinois Inst. of Technology, Inst. of Radio Engineers, Northwestern University and Uni-

PHOTO BY KARSH OF OTTAWA

"Supplier reliability is a must to sound product development"

—R. W. SWANK, Research and Development, Smith-Erie Div., A. O. Smith Corp.

"We count Sharon Steel as one of our most dependable suppliers, and this is extremely important to a development engineer," says R. W. Swank, Manager of Research and Development of service station pumps in the Smith-Erie Division of A. O. Smith Corp.

Shown here with P. R. Fishburn, Manager of Manufacturing, Swank points out "If we can design with the knowledge that we need not be concerned about material analysis variation, our jobs are made that much easier. We've found we can expect this kind of supplier reliability from the *Sharon Steel Corporation, Sharon, Pa.*"

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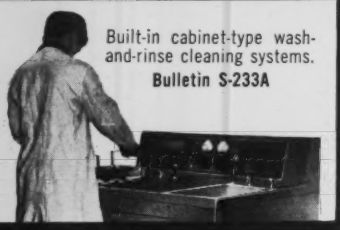

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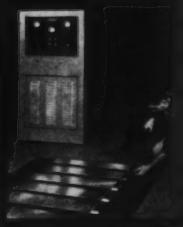
Bulletin S-233A

Modular cabinet-type systems with Cleaning, Filter / Heater / Recirculator, Rinsing, and Drying units.
Bulletin S-236



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News OF INDUSTRY

versity of Illinois. Chicago. Oct 12-14.

SOCIETY OF PLASTICS ENGINEERS, Southern California Section, national technical conference. Los Angeles. Oct 13-14.

ELECTROCHEMICAL SOCIETY, INC., 116th meeting. Columbus, Ohio. Oct 18.

MAGNESIUM ASSN., 15th annual convention. New York City. Oct 19-20.

NATIONAL ASSN. OF CORROSION ENGINEERS, Cleveland Section, 4th annual North Central regional meeting. Cleveland. Oct 20-22.

FEDERATION OF PAINT AND VARNISH PRODUCTION CLUBS, 37th annual meeting. Atlantic City, N. J. Oct 22-24.

NON-FERROUS FOUNDERS' SOCIETY, annual meeting. Bedford Springs, Pa. Oct 22-24.

GAS LUBRICATED BEARINGS, first international symposium, conducted by Franklin Inst., Washington, D.C. Oct 26-28.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS, South Texas Section, 14th annual technical meeting. Galveston, Tex. Oct 30.

METALLURGICAL SOCIETY, American Institute of Mining, Metallurgical, and Petroleum Engineers, Inc., fall meeting. Chicago. Nov 2-5.

AMERICAN SOCIETY FOR METALS, 41st national metal exposition and congress. Chicago. Nov 2-6.

AMERICAN NUCLEAR SOCIETY, winter meeting. Washington, D. C. Nov 4-6.

PORCELAIN ENAMEL INSTITUTE, 21st annual shop practice forum. Columbus, Ohio. Nov 4-6.

STEEL FOUNDERS' SOCIETY OF AMERICA, 14th technical and operating conference. Cleveland. Nov 9-11.

AMERICAN SOCIETY OF INDUSTRIAL DESIGNERS, meeting on "Planning by Design—In a World of Product Change." New York City. Nov 12-13.

5TH CONFERENCE ON MAGNETISM AND MAGNETIC MATERIALS, American Inst. of Electrical Engineers; Office of Naval Research; Metallurgical Society of AIME; American Physical Society; and Inst. of Radio Engineers. Philadelphia. Nov 16-20.

"TREATMENTS AND FINISHES FOR AEROSPACE MATERIALS" Conference, American Electroplaters' Society and Southwest Society of Aircraft Materials and Process Engineers. Fort Worth, Tex. Dec 8-9.

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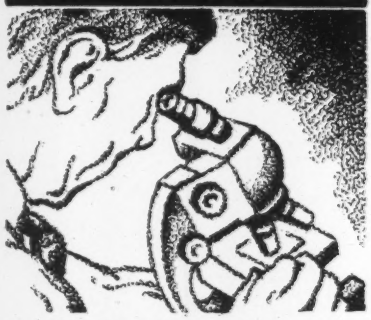

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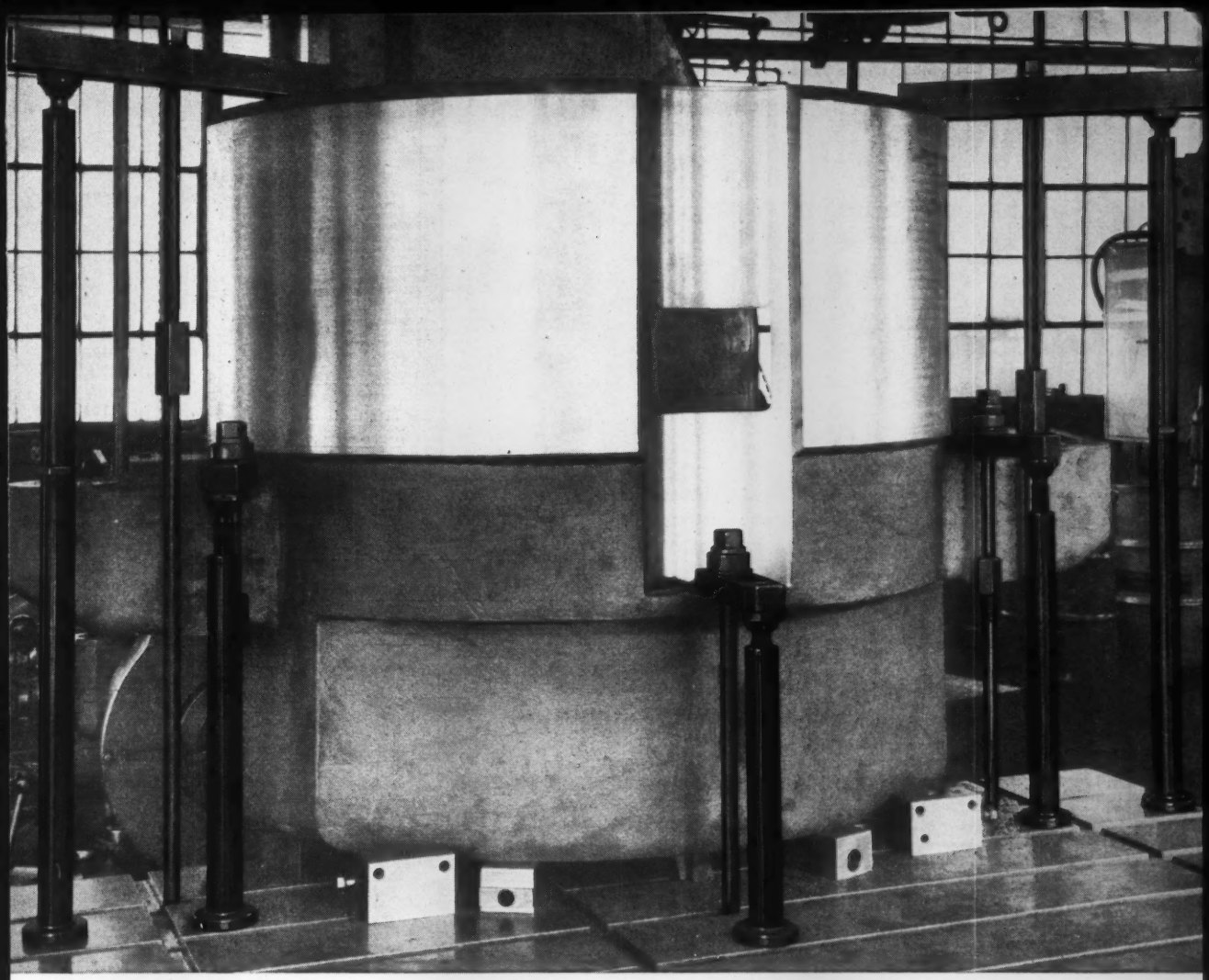

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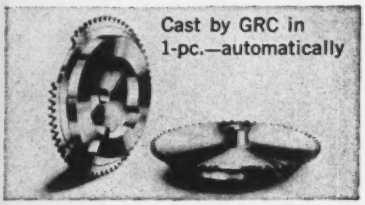

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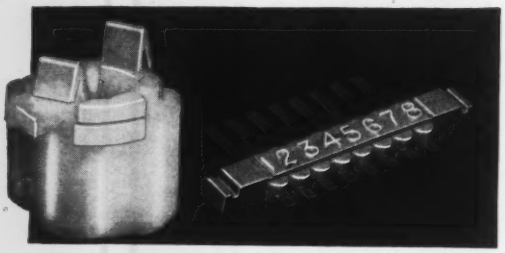

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TECHNICAL LITERATURE

(cont'd from p 45)

Books

High Temperature Materials. *Edited by R. F. Hehemann and G. M. Ault. John Wiley & Sons, Inc., New York. 1959. Cloth, 6 by 9 in., 544 pp. Price $17.50*

Until recently, high temperature materials were centered primarily around nickel and cobalt-base alloys and cermets. Parts 1 and 2 of this book summarize the characteristics of these materials and the factors that control their performance. Since these materials, as developed to date, appear to be limited to temperatures below 2000 F, recent interest has shifted somewhat to the refractory metals. These metals are discussed in Part 3.

Of the various methods for obtaining high strength, dispersion hardening has attracted most attention. This is due, in part, to the extraordinary properties of sintered aluminum powder (SAP). The characteristics of dispersion hardened materials are presented in Part 4.

Gas-metal interactions are of fundamental importance in the field of high temperature alloys. Some of these interactions are discussed in Parts 5 through 7.

Radioisotopes for Industry. *R. S. Rochlin and W. W. Schultz. Reinhold Publishing Corp., New York, 1959. Cloth, 5 by 7½ in., 190 pp. Price $4.75*

Discusses the use of radioisotopes in the plastics, steel, paint, paper, glass, textile and electronic industries for gaging, tracing, testing, inspection and wear measurements.

Metal Industry Handbook and Directory: 1959. *Iliffe & Sons Ltd., London, England. 1959. Paper, 6 by 9 in., 564 pp. Price $3*

Properties, dimensions and prices of ferrous and nonferrous metals. Information also on electroplating and allied processes. Contains a buyers' guide listing British companies making ferrous and nonferrous castings, sheet, strip, plate, rods, wire, tubing, foil, ingots, bars and forgings.

Field Applied Paints and Coatings. *Building Research Institute, National Academy of Sciences, Washington, D. C. 1959. Paper, 8½ by 11 in., 150 pp. Price $5*

Includes all the latest information on paints and coatings, methods of application, causes of deterioration and techniques for maintenance. Special consideration is given to paints for industrial use. A section on color describes the functional use of color and the effect of color on the performance of the paint.

Symposium on the Basic Mechanisms of Fatigue. *Special Technical Publication No. 237. American Society for Testing Materials, Philadelphia. 1959. Cloth, 6 by 9 in., 128 pp. Price $3.75*

The six papers discuss internal friction, plastic strain and fatigue in metals and semiconductors; slipband formation and fatigue cracks of different materials under alternating stressing; fatigue crack forma-

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TECHNICAL LITERATURE

tion in silver chloride; dislocation behavior in lithium fluoride crystals during cyclic stressing; cycle-dependent stress relaxation; and a proposed mechanism of fracture by fatigue.

Creep of Engineering Materials. *Iain Finnie and William R. Heller. McGraw-Hill Book Co., New York. 1959. Cloth, 6 by 9 in., 327 pp. Price $11.50*

Discusses mechanisms involved in the creep of different classes of materials; advances in newly developed metals for use in aircraft and nuclear power; creep testing; stress analysis under creep conditions; measurement of creep variables, such as temperature, strain and load; factors in choosing a design stress; sources, presentation and extrapolation of creep data; and creep problems which occur in specific applications. Typical creep curves and examples of engineering calculations are shown.

Arc Welding in Machinery Design and Manufacture. *James F. Lincoln Arc Welding Foundation, Cleveland, Ohio. 1958. Cloth, 6 by 9 in., 210 pp. Price $2*

Case histories on the use of welded steel construction in rotating machinery parts, heavy bases and frames, high strength miscellaneous members, light bases and frames, and lightly loaded miscellaneous members. Gives suggestions as to what must be considered in good welded machinery design.

Asbestos: Its Industrial Applications. *D. V. Rosato. Reinhold Publishing Corp., New York. 1959. Cloth, 7½ by 5 in., 214 pp. Price $5.75*

Information on asbestos thermal and electrical insulation, packings, gaskets, friction materials, textiles, filters, cements and tile. Gives physical, mechanical, chemical and electrical properties of asbestos.

Fabrication of Molybdenum. *American Society for Metals, Book Dept., Cleveland, Ohio. 1959. Paper, 8½ by 11 in., 221 pp. Price $6.50*

Subjects of 18 papers given in this book include: development of molybdenum-base alloys, welding of molybdenum, protective coating systems for molybdenum, missile structures and power-plants, molybdenum requirements in the nuclear energy field, and testing in the hot rod engine.

Handbook of Practical Electroplating. *Thomas M. Rodgers. Macmillan Co., New York. 1959. Cloth, 5 by 7 in., 345 pp. Price $8.50*

Covers in encyclopedic form all types of electroplating procedures. Each type of plating is described in terms of equipment, solution composition, operation and maintenance. Included are formulas for all the basic plating baths.

Steel in the Soviet Union. *American Iron and Steel Institute, New York. 1959. Cloth, 6 by 9 in., 386 pp. Price $5*

Information on iron mining, beneficiation of iron ores, sintering, blast furnace facilities and practices, steelmaking facilities and practices, rolling mills and rolling practices, and labor relations in the Soviet Union.

Vacuum Metallurgy. *Edited by R. F. Bunshah. Materials Technology Series. Reinhold Publishing Corp., New York. 1958. Cloth, 6 by 9 in., 487 pp. Price $12.50*

Subjects covered in this book are: 1) vacuum equipment, 2) thermodynamics and kinetics, 3) arcs and arc melting processes, 4) induction melting processes, 5) electron bombardment melting techniques, 6) degassing in the liquid and solid states, 7) dis-

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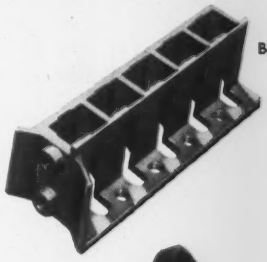
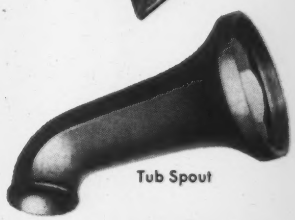
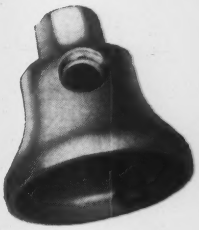
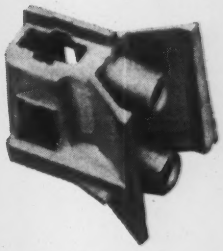

Brush Holder

Brush Holder


Tub Spout


Shower Head Body

Hose Coupling Sleeve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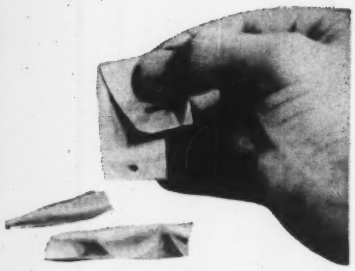

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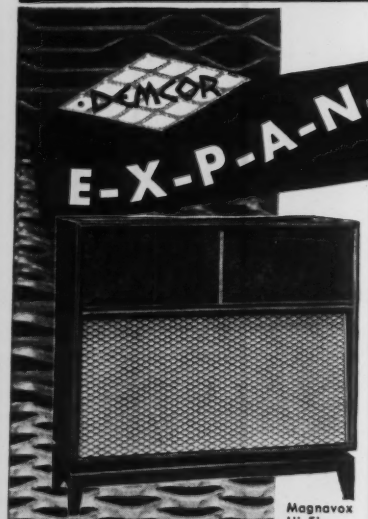

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TECHNICAL LITERATURE

tillation of metals, 8) metallurgical application of vacuum processing, 9) analytical techniques, and 10) future trends.

New Fabrication Techniques. *American Society for Metals, Cleveland, 1959. Paper, 8½ by 11 in., 62 pp. Price $2.95*

This book contains eight papers covering: theory and application of electro-discharge machining; high speed cutting; chemical milling; aluminum impact extrusions; forming at elevated temperatures; adhesive bonding of primary aircraft structures; sandwich constructions; and weld metal for high strength fabrication.

Anti-Corrosion Manual. *Corrosion Prevention and Control (Scientific Surveys Ltd.), London, England, 1959. Cloth, 8 by 11 in., 400 pp. Price $8.50*

Subjects discussed include: 1) theory of corrosion; 2) corrosion in industry; 3) corrosion resistant materials and their applications; 4) preparatory treatments for protective coatings; 5) protective coatings; 6) pipe coatings and tapes; 7) boiler water treatments; and 8) specifications and patents.

Reports

Defects in porcelain enamel. PORCELAIN ENAMEL DEFECTS LITERATURE REVIEW AND DEFINITIONS. *C. E. Collum, G. Steiner and T. A. Wastler, Georgia Institute of Technology. Sept '55. 126 pp. Available from Office of Technical Services, Dept. of Commerce, Washington 25, D. C. Price $2.75 (PB 151053)*

An engineer's guide to the kinds, causes and prevention of defects in porcelain enamel coatings on steel and other metals. Emphasis is placed on delayed defects such as fish scaling.

Forging titanium SOME FACTORS INVOLVED IN FORGING TITANIUM AND TITANIUM ALLOYS. *R. B. Rich, Watertown Arsenal. 36 pp. Available from Office of Technical Services, U. S. Dept. of Commerce, Washington 25, D. C. Price $1 (PB 131945)*

Forging studies on RC-55, RS-55 and RC-130A titanium alloys indicated that the flow stress of RS-55 dropped rapidly up to 1700 stress of RS-55 dropped rapidly up to 1700 F; thereafter, the decrease was very small. In RC-130A the flow stress was approvimately 20% less for each increment of temperature above 1700 F. Generally, the three alloys were insensitive to change in strain rate, especially at higher temperatures.

Radiation damage analysis METHODS AND PROCEDURES FOR RADIATION DAMAGE ANALYSIS. *W. L. Fink, Convair. June '57. 103 pp. Available from Office of Technical Services, Dept. of Commerce, Washington 25, D. C. Price $2.50 (PB 151359)*

Describes analytical methods by which radiation damage data can be used in aircraft engineering design.

Arc welded joints. ARC WELDED JOINTS. *1959. American Welding Society, 33 W. 39th St., New York 18. Price 25¢*

Defines the types of welds and joints most commonly used, and gives examples of methods used for analyzing such joints in design.

Titanium-copper alloys. DEVELOPMENT OF ACTIVE-EUTECTOID BASE ALLOYS. *R. F. Bunshah and H. Margolin, New York University. Oct '58. 51 pp. Available from Office of*

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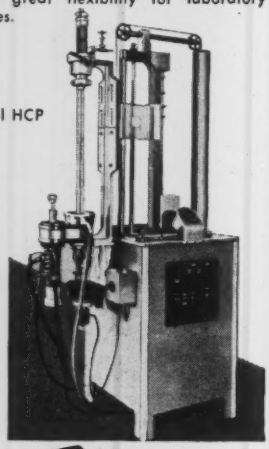

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Soviet research in lubricants. SOVIET RESEARCH IN LUBRICANTS AND LUBRICATION. *Dec '58. 27 pp. Office of Technical Services, Dept. of Commerce, Washington 25, D. C. Price 75¢ (No. 59-11902)*

Survey of Soviet technical literature from 1950 to the end of 1957 indicates that Russia and her satellites are not ahead of the United States in the field of lubricants and lubrication.

Fastener standards. BOLT, NUT AND RIVET STANDARDS. *1959. 288 pp. Industrial Fasteners Institute, 1517 Terminal Tower, Cleveland. Price $8*

Dimensional standards for bolts, nuts, studs, washers, rivets, and machine, cap, tapping and wood screws.

Stainless steels. THE PHYSICAL METALLURGY OF PRECIPITATION-HARDENABLE STAINLESS STEELS. *D. C. Ludwigson and A. M. Hall. Apr '59. 70 pp. Defense Metals Information Center, Battelle Memorial Institute, Columbus, Ohio. (No. 111)*

Summarizes present knowledge on the physical metallurgy of precipitation hardenable stainless steels. The alloys discussed include martensitic, semi-austenitic and austenitic types.

Aluminum-iron alloys THE PREPARATION AND PROPERTIES OF 14 TO 17 PERCENT ALUMINUM-IRON ALLOYS. *A. Foster and D. Pavlovic, Westinghouse Electric Corp. May '58. 41 pp. Available from Office of Technical Services, U. S. Dept. of Commerce, Washington 25, D. C. Price $1.25 (PB 151472)*

Properties, uses and fabrication. Discusses the effects of heat treatment on magnetic properties, with particular emphasis on atomic ordering reactions occurring in the alloy system. Gives properties of low coercive force materials as well as materials with low residual induction.

Die casting standards E SERIES ENGINEERING STANDARDS. *1959. American Die Casting Institute, 366 Madison Ave., New York 17.*

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Method for depositing chromium coatings GROWTH OF CHROMIUM COATINGS FROM LIQUID METALLIC SOLUTIONS. *S. T. Wlodek and J. Wulff, Massachusetts Institute of Technology, Dept. of Metallurgy. Oct '57. 81 pp. Available from Office of Technical Services, Dept. of Commerce, Washington 25, D. C. Price $1.25 (PB 151126)*

Describes a method for depositing chromium coatings on molybdenum by selectively freezing out the coatings from molten alloys of copper-chromium or tin-chromium.

Materials for radomes INVESTIGATION OF IMPROVED MATERIALS FOR AIR SUPPORTED RADOMES. *W. W. Bird and N. E. Wahl, Cornell Aeronautical Laboratories, Inc. Apr. '58. 78 pp. Available from Library of Congress, Photoduplication Service, Publications Board Project, Washington 25, D. C. Price $4.50 (microfilm), $12.30 (photocopy) (PB 137379)*

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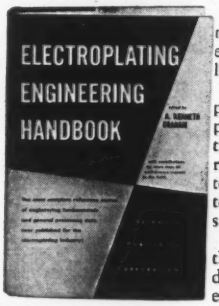

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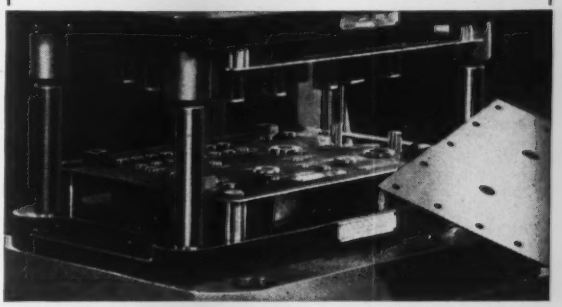

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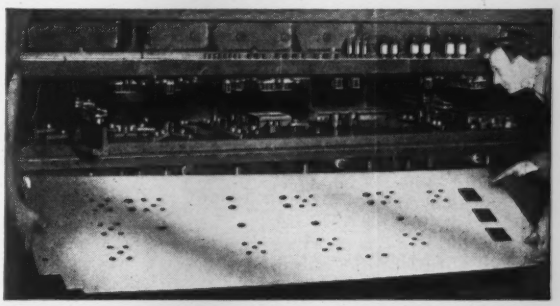

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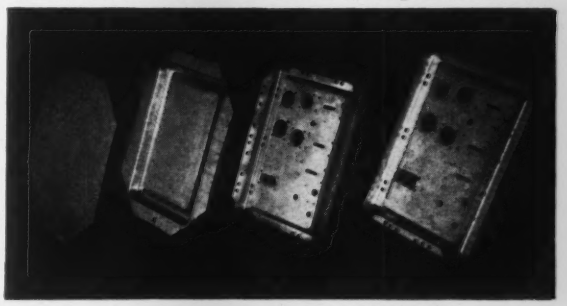

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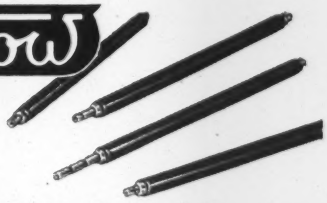

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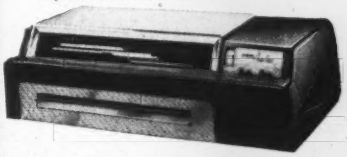

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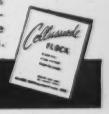

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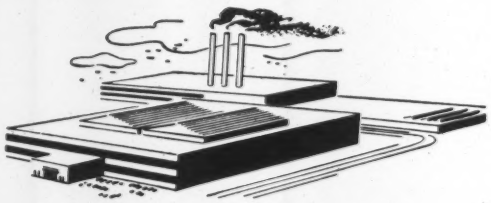

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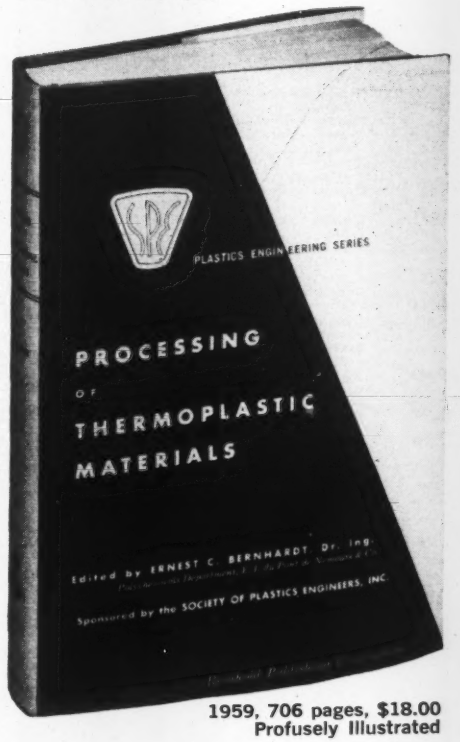

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LETTER TO THE EDITOR:

A Dissent on the Society of Aircraft Materials and Process Engineers

by F. L. LaQue, *Vice President and Manager, Development and Research Div., International Nickel Co., Inc.*

Your editorial on the Society of Aircraft Materials and Process Engineers in the July issue ("A Materials Society for You") prompts me to offer some comments. Although I am currently serving as president of ASTM my remarks are not offered in this capacity so much as they are in the possible capacity of a representative of a large group of engineers in this country who find it increasingly difficult to cope with the ever increasing number of technical societies that require attention to some degree.

Specialized organizations are useful but . . .

There is no doubt that these highly specialized organizations are useful to their members and are responsive to real and substantial needs. The question that arises is whether the organization of new societies such as SAMPE is the best way to deal with the matter. This question becomes especially pertinent when one realizes that in many instances the problems being dealt with could be handled within the framework of an existing technical organization subjected to practical changes or additions to meet the peculiar needs of those concerned.

This is particularly the case in the present instance where all the materials mentioned in your article have been and are being dealt with by appropriate committees of the ASTM. The membership of these committees, in all probability, includes people who must now become concerned with the same problems under new auspices. I doubt that such expansion results in sufficient further progress to warrant the duplication of effort involved.

Existing process, industry groups sufficient

The present situation is complicated further by the concern of the new organization with processes as well as materials. This suggests probable duplication of activities of such well established and competent organizations as the American Welding Society, and equally probable duplication of certain activities of the American Rocket Society and the Institute of Aeronautical Sciences which are more immediately concerned with the general area of interest involved.

Presumably, those who organized the Society of Aircraft Materials and Process Engineers were convinced that the size, complexity and scope of the materials problems in this field, unlike other fields, warranted a specialized society.

Three weaknesses of SAMPE objective

There are at least three weaknesses in such reasoning:

1. It assumes (wrongly) that the materials processing problems encountered in the aircraft-missile field are unique. It would seem that, for example, a welding problem with Inconel X can be common to several industries, although the requirements and treatment may differ.

2. It rejects the importance of cross fertilization of ideas between materials and process engineers in unlike industries. A case may be made to show where industries borrow from each other and not infrequently encounter common material and process problems.

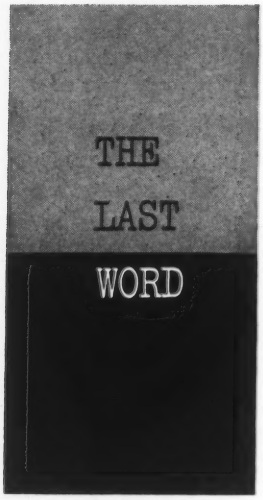
3. It rejects the usefulness of established technical societies such as ASTM, IAS, ARS and others already constituted to service the needs of the aircraft and missile field.

Change orientation of societies if needed

My purpose in drawing your attention to this matter is to suggest that instead of urging your readers to flock to join this new society, you suggest that, before doing so, they explore the advantages of dealing with their special problems within existing organizations and achieve special attention to their peculiar needs by becoming active in the committee work of these organizations. They should be able to influence any necessary orientation while taking advantage of the position already achieved as a basis for further desirable advances.

See "The Last Word" on following page for discussion of Mr. LaQue's letter. →

Why We Favor a Society of Materials and Process Engineers



by ***H. R. Clauser***
Editor

Our comments in this column in July supporting the concept of the Society of Aircraft Materials and Process Engineers (SAMPE) drew many letters, most of them favorable. However, there were some dissents and the letter from F. L. LaQue, published in full on the preceding page, is representative.

It is important at this time to give attention to questions raised in Mr. LaQue's letter because late this month, on Oct 27, members of the seven existing autonomous sections of SAMPE will meet in Los Angeles to discuss the formation of a national society.

Broader scope for SAMPE

For one thing Mr. LaQue questions the need and the value of such a highly specialized society as SAMPE which at present is confined to only one industry. We are in accord with him on this point. If SAMPE does go national, we believe it also should broaden its scope to cover all industries. A national society that is representative of only the aircraft and missiles field would be limited in its activities and would appeal only to materials men in one industry. As Mr. LaQue points out, and as we stated in the July editorial, most materials problems are common to all industries, and interchange of experience and information among materials people in many different fields leads to more rapid progress for all.

Can existing societies do the job?

Perhaps the most important issue raised by Mr. LaQue's letter is whether a new society of any kind is needed to cover the rapidly growing materials engineering field. He believes that existing organizations, and in particular the American Society for Testing Materials, can fulfill the needs of these technical men who specialize in the selection and efficient use of engineering materials.

While we, too, would prefer to see an existing technical society adapt its framework and program to the needs of materials and process engineers, we must reluctantly state that thus far no existing society has sufficiently demonstrated a willingness or ability to do so. By and large, the metals societies have been reluctant to extend their scope to include nonmetallics. The same has been true of the societies in the nonmetallics field.

ASTM framework does not seem suitable

It is true that the American Society for Testing Materials has come closest to serving the needs of materials men who work in the materials-using industries. ASTM covers the whole gamut of engineering materials, and many materials and process engineers are among its members.

But ASTM's principal function is the development of standards and specifications. And to perform this function it has been organized largely along committee lines. Experience shows that such an organizational framework has not been able to meet the needs of the young, but growing, profession of materials engineering. In particular, it has not provided a common meeting place for materials and process engineers to informally discuss their practical, daily problems.

New national society is needed

What is needed is a national society specifically oriented to the interests of materials men in all industries and composed of strong local or regional chapters. Such an organization will provide the opportunity for materials and process engineers to hear and exchange technical information and to discuss the everyday problems that are involved in the selection, evaluation and processing of engineering materials. It will promote the development and use of new and better materials. And, finally, it will increase the prestige and hasten a wider recognition of materials engineering as a profession.

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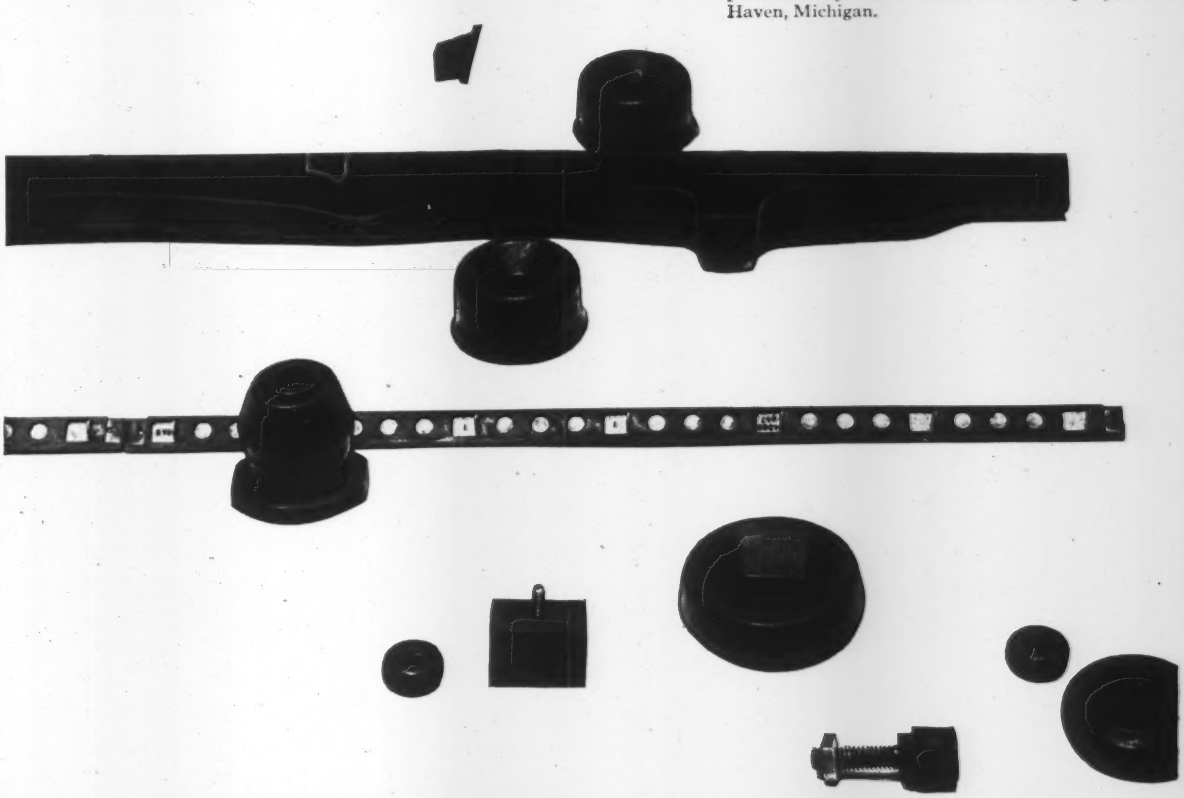

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